RAILWAY ENGINEERING
AND MAINTENANCE OF WAY.
BRIDGES-BUILDINGS-CONTRACTING-SIGNALING-TRACK
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The Railway Signal Association.

THE MEETING of the Railway Signal Association at Chicago, March 20 last, was notable for the dignity of the proceedings, in most favorable contrast to some former occasions. In Mr. Denney, to whose tact and executive ability was due the favorable showing made, the association has a president of which it may well be proud.

As was to be expected, little discussion of reports other than those printed in the advance notice was had. Also, as a matter of course, a great deal of time was spent on trivialities relating to symbols. This is a subject on which almost every person has his own decided opinions and many compromises are necessary. The chief difficulty in the present case was to devise a system to serve equally well the supply men and the roads. It is desirable to emphasize certain features especially for the benefit of one interest that are not of great importance to the other. To devise a system which shall emphasize all characteristics without undue complication is indeed a problem.

The two papers, one on portable storage batteries, the other on alternating current signaling, were both interesting and instructive. The success which has attended the use of portable storage batteries on the Harriman Lines makes any account of their methods most acceptable. Alternating current signaling is now coming so rapidly to the fore that a knowledge at least of the fundamentals is essential to every signal engineer. For this reason alone the paper presented was most welcome and is a valuable addition to the literature on the subject. The two papers will be published in a later issue.

Manganese Steel Frogs.

IN A REMARKABLY short time the manganese steel frog has come into favor with many of our leading railroads. The manufacturers at first met with considerable difficulty in inducing railroads to buy, on account of the increase in cost, compared with the ordinary frog. It was easy to demonstrate the superior quality of manganese steel, but no actual examples of increased wear and resultant economy in railroad use were available. At the present time, proof of great wearing qualities is easily obtained, and this greater wear leads to economy in cost of material and maintenance. It is claimed that a solid center manganese frog will outwear three ordinary frogs, and the claim does not appear to be an extravagant one. If this be true there is a direct saving of the cost of two ordinary steel frogs; there is a saving of switch ties due to less spiking; there is a saving in the labor cost of replacing frogs; there is saving in the labor cost of replacing ties; and there is a saving in the labor cost of maintenance.

It is frequently the case that frogs will wear out more rapidly than the ties on which they lay. In cases where frogs require frequent replacing, the ties soon became full of spike holes, and such ties must be removed, although otherwise they may be perfectly sound. Frequent changing of the frogs then, causes more frequent tie renewals, entailing an expense for new ties, and a labor expense for tie replacement. It is plainly evident that longer wearing frogs give a labor economy in frog replacements. Frog wear is

greatest where traffic is heaviest and where trains are frequent. At such places the cost of renewals is highest, owing to the limited time available between trains, to the inaccessibility and difficulty of transporting track material, and to lack of space for carrying on replacement work advantageously. If traffic is delayed by replacements, that is an added expense and inconvenience which should be considered.

The economy in using manganese frogs in high speed interlocking railway crossings is especially evident. Such crossings are frequently on sections where very small section gangs are employed, and the frogs used are generally much heavier than a switch frog. In order to handle such replacements advantageously, laborers are brought in from other sections, entailing trouble and expense. As regards the number of men required for replacing such a frog, there is no economy as a manganese frog is at least as heavy as an ordinary frog. As regards the number of times such extra men will be required, there is a distinct saving, as the manganese frog effects a saving of the number of replacements. An economy in maintenance is effected, for the road bed is dug up less frequently, and consequently less surfacing is necessary. The use of a solid center manganese frog eliminates the tightening and replacing of frog bolts.

The manganese frog is replacing the spring rail frog to some extent, as the point of the manganese frog is able to withstand rail wear, without the additional support of the wing rail. The advantage of a spring rail frog lies in the fact that the frog point is given a support by the wing rail, making the point nearly as strong as a continuous rail, (that is, when a train passes on the main track side.) In interlocking plants where both sides of a frog are to be used equally, the spring rail frog is not suitable, and here the manganese frog becomes of especial value.

Government Investigating Boards.

THE APPOINTMENT OF an increasing number of Government investigating boards is a step in the right direction. If the merits and demerits of a proposed innovation or improvement in engineering apparatus can be determined in advance, legislation ought to be greatly influenced in the passage of practical and beneficial laws. However, only appliances or policies which affect the welfare of the nation as a whole, are of sufficient importance to justify the appointment of such investigating boards, and the investigators should be disinterested men of known ability and experience in there special lines.

In the past the policy has been to leave much of the investigation and consideration of proposed laws to legislative committees. The personnel of legislative committees is liable to frequent change so that it is unlikely that any committee will remain intact long enough, or will have time enough for as thorough an investigation as is often necessary. Interested promoters may by misrepresentations influence the actions of the committee, which in turn is likely to influence the legislators to whom the report is made. It is certain that every legislator cannot give minute attention to the details to be affected by each law. And since the lawmaker must take, to a certain extent, opinions of others, it seems advisable that he should have practical opinions based on the investigations of experienced experts. The results which Government Investigating Boards have obtained up to the present, have been in general, highly satisfactory, for usually investigations have been conducted thoroughly and in a businesslike manner.

Distribution of Track Material.

UNLOADING TRACK material cheaply and with the least labor is a problem of great importance, but it is of equal or greater importance that the correct quantities of materials be unloaded, and that these quantities be correctly spaced. Cheapness in unloading track material may be very easily offset or overbalanced by increased cost of track laying, if there is too much or too little material, or if it is not placed conveniently. This is especially true of relaying track, double tracking, or putting in new switches. If track is being laid with a tracklaying machine materials are used immediately when distributed in order to make a track on which to move the machine forward, thus the distribution of rails, angle bars and ties is automatically correct, and the problem narrows itself to the proper loading of the material, and of the distribution of the finishing material behind the machine. Again, even if there is poor distribution of spikes, bolts, etc., behind a track laying machine, the dumpy may be used advantageously to redistribute the material, and more is easily obtained from the frequently passing material trains.

If ties are being distributed ahead by teams, a great deal of judgment must be used in order to get proper distribution, and a great deal of ingenuity must be used sometimes in order to get them distributed at all, if the country is rough, and the right-of-way is crossed by many streams.

When building a second track, i. e., when double-tracking the material is usually distributed by a work train, which necessarily uses a track on which there is more or less traffic. The material is generally distributed a long ways ahead of the track gangs. Possibly the work train will have been taken off the work entirely when track laying begins; then if there is a shortage of steel the track gang will be forced to transport rails by hand until a work train can be procured to distribute more rails. It is better for the track laying gang if there are too many rails and ties rather than too few. However, all surplus material must afterwards be loaded, which is an unnecessary expense. Shortage of ties tends to temporarily break up the organization of the track layers, for if the men are properly placed to just handle the work when all the ties are there, some part of the gang will be underworked or overworked when ties are short. Also, when fill-in ties do arrive the organization must be broken up to go back and finish up the track.

If just enough rails and ties are unloaded, and yet they are not properly placed, i. e., if they are unloaded in bunches, the redistribution must be made with the dumpy, which must be used on the main track, and the dumpy must usually be protected by flagmen. When the rail setters or tie spacers

must redistribute material with the dumpy, they will be unable to keep ahead of the rest of the gang, and the organization must be again broken up in order to get a day's work out of each man.

All of these arguments may not be necessary in order to prove that track material should be properly distributed; that fact is apparent, but nevertheless it is true that many times track material is not properly distributed. Correct distribution from a main track can be obtained by noting the standard length of track rails and spotting the material train with respect to the rail joints, and unloading spikes, angle bars, ties, etc., in the proper proportion. If it is desired to keep the train in motion while distributing any material (such as is frequently done in distributing bolts, spikes, angle bars, etc.), an easier method is to gage the distribution by the position of telegraph poles, which are spaced at standard distances and can be seen without trouble by the men on the cars.

The importance of having on hand all the material required before starting a job cannot be overestimated. Lack of material causes loss of money while a gang is being delayed, and causes a demoralization of the gang organization. The men soon find out that there is a delay, and become indolent on the work which the foreman improvises in order to kill time. And when real work starts again, it is a hard task for the foreman to get them in the habit of working.

New Passenger Station at Madison, Wis. C. & N. W. Ry.

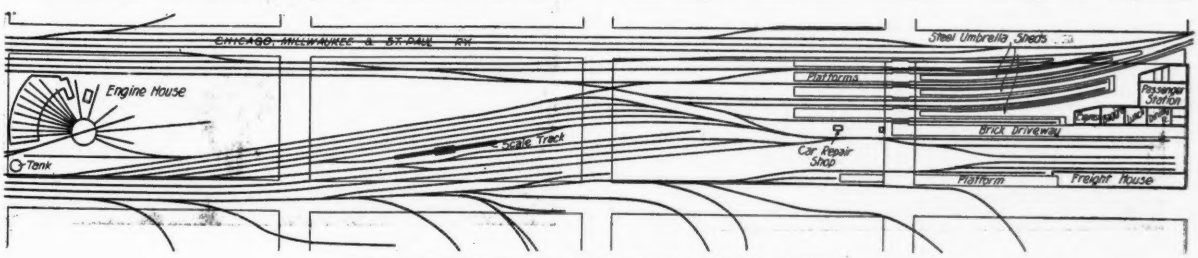
On Dec. 15, 1910, the Chicago & Northwestern Ry. opened its new Madison depot to the public. Preliminary work was begun in March, and excavation for the depot building was begun in April, 1910. The station was opened eight and one-half months after excavation was commenced.

C. & N. W. Railway Passenger Station, Madison, Wis.

The new station occupies substantially the site of the old. It is built of gray stone in the Italian Renaissance style, and the main part, two stories high, fronts 127 feet on Blair street. There is a one story part on the west which extends about 200 feet north. The general scheme of the structure may be defined as a combination terminal- and through-station, since of its six tracks, four terminate at the concourse, and the remaining two (the main lines) accommodate the through trains.

In the center of the Blair street facade is the main entrance, a two story flat arch with unusually deep reveals, the prominence of which is increased by a broad marquise of copper and glass, designed to protect travelers in stormy weather.

Entering at this door one passes through an imposing



Track Plan, New C. & N. W. Station, Madison, Wis.

Women's Waiting Room, North Western Railway Station, Madison, Wis.

marble vestibule into the general waiting room. This room, the dominant feature of the station, is 50 feet wide, 78 feet long and 32 feet high. The floor is of marble tile and the walls are faced with Tennessee marble to a height of 23 feet, above which ornamental plaster is carried up to a heavy beamed ceiling. The room is finely lighted by many clerestory windows.

Partially surrounding and communicating directly with the general waiting room are the smaller waiting rooms, ticket office, dining room and the minor offices. The lunch and dining room, 35 feet wide and 80 feet long, is wainscoted with green Grueby tile, treated above with decorated plaster. This is under the general control of the dining car department of the company, and consequently the same service may be expected here as is given on the most up-to-date of the company's through trains.

The north end of the general waiting room opens directly onto the sheltered concourse, which is 50 feet by 70 feet and extends along the north and east sides of the station to Blair street. From this concourse passengers go to their trains through gates that lead to the track platform. These platforms, three in number and each 20 feet in width, are protected from the weather by shelter sheds 400 feet long, of cast iron and steel covered by concrete roof.

The second story of the main part of the station is used

Ceneral Waitinꝫ Room, Lookinꝫ Towards Concourse.

A Corner of the General Waiting Room.

by the railway company for division offices and is reached by a stairway leading up from the east platform.

West of the passenger station is the present freight station connected to the station by a high wrought-iron fence that is relieved at intervals by brick and stone posts. This fence effectively screens the freight tracks from the pedestrian in Blair street. It is interrupted by two driveways, one leading to the baggage and express rooms and the other to the freight yards.

A vast amount of other work had to be done, besides the actual building of the new station, and this fell under the care of the company's engineering department. The yard tracks and main lines, lying immediately north of the station, were entirely re-arranged. The two main tracks were reconstructed and their location changed farther east, paralleling Wilson street as far north as the round-house, at which point the main lines turn to the west and merge into the old location, just south of the Yahara River crossing. The leads and yard tracks were rearranged to fit the new conditions, and three new tracks, serving the passenger terminal proper, were constructed immediately north of the station.

On account of being the capital city of Wisconsin, and also because the State University (with upwards of 5,000 students) is located there, Madison is a great center for passenger traffic, and the Chicago & Northwestern Railway has constructed a depot commensurate with its extraordinary needs and demands. Among all the attractive public and scholastic buildings of the city, the new passenger station easily holds a prominent place.

The illustrations herewith are published through the courtesy of the editor of "The North Western."

Report of the Twelfth Annual Convention of the American Railway Engineering and Maintenance of Way Ass'n.

The first session of the twelfth annual convention of the American Railway Engineering and Maintenance of Way Association was called to order at 9:30 a. m. on Tuesday, March 21, in the convention hall of the Congress Hotel, by the president, L. C. Fritch, chief engineer of the Chicago Great Western.

The minutes of the last meeting were approved, without reading, and the president then read his annual address.

TUESDAY, MARCH 21.

PRESIDENT'S ADDRESS.

To the Members of the American Railway Engineers and Maintenance of Way Association:

The progress made by the association during the year just passed has been gratifying, and the thanks of the association are due its committees for their efficient and painstaking labors and the splendid results secured. That interest and enthusiasm in the work has been sustained, is attested by the fact that all of the twenty-two standing and special committees have presented valuable and comprehensive reports for consideration at this convention.

It is noteworthy that in the midst of the busy lives of the members, time is found to accomplish so large an amount of work, and to perform it in the efficient and thorough manner in which it is presented. This feature is all the more praiseworthy, when it is considered that this organization is a voluntary one, and the time devoted by the members to committee work is frequently given at a great personal sacrifice and at the expense of much-needed rest.

Prior to the formation of the association, few railways pursued the same methods or used similar appliances or devices, in so far as railway engineering and maintenance of way work was concerned, even under similar climatic, physical and commercial conditions, and there was little, if any, approach to uniformity as to methods and practices. A fertile field seemed, therefore, to exist, in which it was believed much good might be accomplished by formulating principles of practice and disseminating knowledge pertaining to maintenance of way work.

This association was formed for "the advancement of knowledge pertaining to the scientific and economical location, construction, operation and maintenance of railways," and to attain those ends it was deemed essential to investigate matters pertaining to the objects of the association through standing and special committees; to hold meetings for the discussion of papers and reports; to publish its conclusions and to maintain a library.

The founders of the association wisely concluded that the best results would be obtained through committees, the members of which should be selected with due consideration of their qualifications to deal with particular subjects.

The work of the association was laid out on unique lines. The entire field of railway engineering and maintenance of way work was originally divided into sixteen divisions, and a committee appointed to deal with each subject. Now we have nineteen standing committees, and additional special committees to consider matters not coming within the province of the regular committees.

Each committee is given a particular phase of the general subject, and they are requested to collect all available information on the subject in hand, to digest carefully the data obtained, to draw therefrom such conclusions as the information seems to warrant, and to submit to the association its recommendations thereon. Committee reports are to be formulated on the following general plan: An historical review of the subject under discussion, with an outline of its origin and development; an analysis of the most important elements of the subject-matter; an argument, showing the disadvantages of the old and the advantages of the recommended practice; and, finally, the conclusions of the committee, giving in concise language and in logical sequence its conclusions and recommendations. That these methods have been productive of excellent results is abundantly shown in our proceedings for the past decade.

However, the formulation of principles of practice is not the only or main function of our association. The collection and dissemination of knowledge pertaining to the scientific and economical location, construction, operation and maintenance of railways is quite as important, and it will be conceded that along these lines the association has made an enviable record. Since the formation of the association there have been issued over twenty thousand pages of printed matter, all of it live and useful material pertaining to our profession.

While it may be true that not all of our recommendations have met with universal approval, nevertheless they have served as a guide to the engineer in arriving at a solution of his problems. It would be practically impossible to formulate principles of practice applicable to all sections of the country, with its diversity of conditions of soil, climate and commercial requirements.

Some of our critics have said, "your association is gathering an immense amount of valuable information, but your conclusions are not always sound. Your committee reports need boiling down, the wheat needs winnowing from the chaff."

My own opinion is that there is no foundation for these criticisms, which is evidenced by the fact that our proceedings are used as works of reference by the ablest engineers, not only of this country, but of the world.

There is a Roman adage that says, "whatever you do, do it well, and always consider the consequences of what you do." This is wise counsel, and, in my judgment, it applies to our own work. We should be careful not to spend too much time and effort on details and peculiar methods and neglect underlying principles upon which all good practice is founded. We should aim at principles that may be universally applied. For example, good, sound specifications covering the materials of engineering, which are susceptible of universal application, are of more use than methods or particular plans or designs, which have only limited application. The work of our association that will stand out prominently is that which is of the greatest use to the greatest number.

Perhaps too much stress is laid upon the establishment of standards. In a progressive art, such as ours, there should be no such word as "standard." What is standard today may be obsolete tomorrow. Improvement and advancement is the order of the day, and in no profession is this truer than in our own.

The progress of railway engineering during the past year is perhaps best exemplified in the opening for service of the New York terminals of the Pennsylvania, including the tunnels under the Hudson and East rivers. This great achievement, made possible only by the ability, foresight and courage of that splendid type of man and engineer, Alexander J. Cassatt, is a fitting and lasting tribute to his genius and memory. It marks an epoch in railway progress, being the first large trunk line railway terminal, complete in its operation with the use of electric traction. This installation awakens us to the sense of a new responsibility that is placed upon us as engineers, and that is, that we should prepare ourselves for the new problems that it will be our duty to solve. It will devolve upon the engineers of our railways to determine to what extent this new power is justifiable in heavy trunk line service. The question of electrification of trunk lines, and its application to terminals in large cities, has assumed the proportions of a public question in the cities of Boston, Philadelphia, Baltimore, Washington, St. Louis, Chicago, and its extension in New York City to all classes of service is being considered.

It is a problem of great magnitude and involves not only technical skill, but judgment of the highest order, and its solution must, in the final analysis, be made by railway men, familiar with the intricacies of railway operation and its needs. My advice, therefore, would be, that railway engineers prepare for this economic change that has already begun, in order that the problems that demand solution may be solved on a sound basis, and that costly mistakes which ignorance would otherwise impose, may be avoided.

We will miss some familiar faces at this convention—men who have aided us in placing this association on its high plane of usefulness. Among those who have gone to that "other country from whose bourne no traveler ever returns" are Octave Chanute and Samuel M. Rowe, both pioneers in the art of wood preservation; E. P. Dawley, an efficient member of the committee on electricity; John F. Hinckley, a valued member of the rail committee; Ira G. Rawn, an able member of our first committee on yards and terminals; J. E. Schwitzer, late chief engineer of the Canadian Pacific, a valued member of the committee on economics of railway location; H. L. Laughlin, an efficient member of the committee on track.

A notable achievement made during the past year, through the co-operation of the Master Car Builders' Association and our association, is the final solution of the question of the disposal of brine drippings from refrigerator cars, which has been the bane of railways for nearly thirty years. The conclusion reached provides for retaining the brine drippings in tanks between icing stations, and draining them at given points, where facilities are provided for that purpose. This will result in preventing injury to maintenance of way structures and equipment costing the railways in the past thousands of dollars.

There are two important matters coming before this convention

for final vote. The name of the association, which has been unfortunately cumbersome in its length, is to be changed to one of shorter length, a desirable innovation.

The proposed change in the constitution, which will grant to the membership at large a voice in the selection of officers of the association, is one that will meet with universal approval.

The railway industry is being circumscribed by governmental regulations to the extent that its operations, to the minutest details, are being regulated by law or prescribed by rules of commissions created under federal or state authority. Some of these regulations are wise and beneficial, and were necessary to purge the railway business of its past sins of omissions and commission. However, many of the regulations, conceived by irresponsible persons and for sinister purposes, are a positive menace to the public they were designed to benefit; these will serve no good purpose, but prove a positive check to railway development. In this feature we are vitally interested, and it devolves upon us as citizens, true to our calling, to educate the public to a realization of the rights and the justice that is due the railway industry.

It has been asserted that railways are extravagant and wasteful in their methods of operation, and lack system in conducting their business. These charges are not in accordance with the facts as we know them. Organizations similar to our own are giving their best thought to the improvement of methods and to the promotion of efficiency in all departments of railways.

We have an abiding faith in the fairness and common sense of the American people, and that our incomparable country will progress with undiminished momentum. New lines of railways will continue to be built, existing lines will be revised and rebuilt, and herein lies our duty.

The charter of our existence provides that we shall devote ourselves to the "advancement of knowledge pertaining to the scientific and economical location, construction, operation and maintenance of railways." We maintain that our association has justified itself and that in the future, as in the past, we will endeavor to do our work honorably, thoroughly and conscientiously, irrespective of regulations, as is the desire of every member of the American Railway Engineering and Maintenance of Way Association.

In closing the term of office as president, I wish to thank the board of direction for its hearty co-operation, the secretary for his untiring devotion to duty, and the committees for the splendid work which they have accomplished.

The report of the secretary and treasurer showed the following statements:

Total membership at last annual convention		869
Withdrawals during the year	11	
Deceased members	7	
Dropped for non-payment of dues	20	
	38	38
		831
Additions during the year		136
Total membership, March 15, 1911		967
Consisting of:		
Active members		908
Honorary members		3
Associate members		56
		967

Geographical Distribution.

The geographical distribution of the membership is indicated in the following table:

United States	838	Panama	2
Dominion of Canada	76	Australia	1
Mexico	14	Brazil	1
Japan	7	Germany	1
Cuba	6	Great Britain	1
China	5	Guatemala	1
New Zealand	4	Peru	1
Philippine Islands	4	Russia	1
India	2		
Korea	2	Total	967

Classification of Members.

The positions held by the members are indicated in the following table:

Presidents	16
Assistants to Presidents	3
Vice-Presidents	28
General Managers	18
Director Maintenance and Operation	1
Assistant Director Maintenance and Operation	1
Assistant General Managers	6
General Superintendents	10
Assistant General Superintendents	2
Division Superintendents	34
Chief Engineers	114
Assistant Chief Engineers	24
Principal Assistant Engineers	15
Chief Engineers Maintenance of Way	6
Assistant Chief Engineers Maintenance of Way	1
Engineers of Construction	12
Engineers Maintenance of Way	89
Bridge Engineers	28
Engineers Surveys	1
Tunnel Engineers	1
Division Engineers	90
Assistant Engineers	97
District Engineers	14
Electrical Engineers	4
Inspecting Engineers	11
Supervising Engineers	3
Architects	5
Locating Engineers	3
Engineer Track Economics	1
Engineers Track and Roadway	5
Designing Engineers	2
Maintenance of Way Accountant	1
Engineer B. & B.	1
Office Engineers	7
Chief Draftsmen	5
General Roadmasters	2
Roadmasters	14
Master Carpenters	3
Rail Expert	1
Superintendent Bridges and Buildings	3
Supervisors	2
Resident Engineers	30
Signal Engineers	20
Assistant Signal Engineer	1
Managers Timber Department	5
Timber Inspector (Chief)	1
Forester	1
General Foreman Water Works	1
Supervisor Materials	1
Chemists and Eng. Tests	2
Metallurgical Engineers	2
Engineer River Protection	1
Professors in Colleges	16
Associate Professors	16
Government Employes	13
Civil Engineers	59
Consulting Engineers	75
Contracting Engineers	20
Engineer Grade Elimination	2
Purchasing Agent	1
General Agents	2
Receiver	1
Editors	3
Miscellaneous	6
Total	967

Financial Statement.

Balance on hand March 12, 1910	$15,382.57
Receipts during the year	26,423.95
Expenditures during the year	28,593.49
Excess of expenditures over receipts	$ 2,169.54
Balance cash on hand March 15, 1911	13,216.62

Wm. McNab (Grand Trunk Railway): Before the business of the association begins, may I be allowed to express to the members of the association the regret of Past-President Howard G. Kelley at his inability to be present at these sessions? Mr. Kelley is in Southern California, having taken his wife there to recuperate after a severe illness. This is the first convention since the inception of this association that Mr. Kelley has missed. His disappointment at his non-attendance is keen, but I do not think it is any more so than the members of this association feel at the present time at his absence. I ask your indulgence in allowing me to make these remarks, so that Mr. Kelley's regrets may go on record.

RULES AND ORGANIZATION.

In connection with the work of the committee, books of rules of 61 American railways have been secured and a compilation made showing the subjects covered by them. A few of these rules have been selected and are now presented as an appendix to this report. These rules cover the following subjects:

I. Absence from duty.
II. Accidents.
III. Ballast—covering the purpose for which ballast is used, material, cross-section, preparation of sub-grade, handling, tamping, surfacing, etc.
IV. Batteries—covering the duties of battery-men and care of battries.
V. Cars—relative to loading and unloading of roadway material.
VI. Deportment.
VII. Discharging men.
VIII. Drainage.

Under the first of the instructions of the board of direction the committee recommends the following changes in the Manual:

Rule 4 under "General Notice" shall be revised to read:

"4. Employees must exercise care and watchfulness to prevent injury to themselves, other employees and the public, and to prevent damage to property. In case of doubt they must take the safe course. They must know that all tools and appliances are in safe condition before using. They must move away from tracks upon approach and during passage of trains, and, so far as practicable, prevent the public from walking on tracks or otherwise trespassing on the right-of-way."

Under the heading "General Notice," add two additional new rules as follows:

"10. Employees must not without proper authority absent themselves from duty, exchange duties with others or engage substitutes."

"11. Employees must conduct themselves properly at all times. They must be civil and courteous to fellow employees and patrons of the road. Employees who are dishonest, vicious, quarrelsome, or use profane, vulgar or immoral language, must be discharged."

Under "Rules Governing Track Foremen, Bridge and Building Foremen and Signal Foremen." Rule 4 in each case shall be revised to read:

"4. They shall employ men as the ——(Title)—— directs. They must treat employees with consideration, and see that they properly perform their duties. They must discharge men who are incompetent or neglect their duties, but in no case shall they discharge men without cause. They must keep the required records of the time of their men and of the materials used."

Under "Rules Governing Track Foremen," Rule 5 shall be revised so that the last clause shall read:

"Foremen must provide themselves with reliable watches, and, when possible, compare time daily with a standard clock or with the watches of other employees who are required to have the standard time."

Under the second instruction of the board of direction it is recommended that Rules 1, 2, 3, 4, 5 and 6, under the heading "Inspection of Track," now published on page 66 of the Manual, be omitted in future revisions.

Under the third instruction it is recommended that the instructions to next year's committee provide that rules in the nature of specifications or instructions regarding the conduct of work be prepared, making use of the recommendations of the various committees dealing with these subjects, and of the best practice of the railway companies as embodied in their Books of Rules, with a view to providing material which may be of assistance to railroads formulating maintenance of way rules.

The report is signed by: Jos. O. Osgood (C. R. R. of N. J.), chairman; F. L. Nicholson (N. & S.), vice-chairman; F. D. Anthony (Q., M. & S.), G. D. Brooke (B. & O.), S. E. Coombs (N. Y. C. & H. R.), E. J. Correll (M. P.), B. T. Elmore (Virginian), A. S. More (C., C., C. & St. L.), G. L. Moore (L. V.), D. B. Johnston (Penn. Lines), D. W. Richards (N. & W.).

Appendix.

Suggestions for New Rules.

In connection with the work of the committee this year books of rules of 61 American railways have been secured and a compilation made showing the subjects covered by them. These rules have been studied and suggestions for new rules are here made for a number of subjects.

Absence from Duty.

Employees must not without proper authority absent themselves from duty, exchange duties with others or engage substitutes.

Accidents.

General.—Track foremen must, in case of accident, promptly render all assistance in their power, whether the accident occurs on their own or adjacent sections. They shall investigate and report on Form No. .... all accidents occurring on their sections, which may be attributable to, or result in damage to track, roadbed or structures, and preserve all materials which may assist in determining the cause.

Watchmen.—Track foremen must, in case of accident, promptly render all assistance in their power, whether the accident occurs on their own or adjacent sections, and when necessary appoint watchmen to guard the premises and prevent stealing. They shall investigate and report on Form No. .... all accidents occurring on their sections, which may be attributable or result in damage to roadbed or structures, and preserve all materials which may assist in determining the cause.

Accidents to Individuals.—Employees must exercise the greatest care and watchfulness to prevent injury or damage to themselves, other employees, the public and to property, and in case of doubt take the safe course. They must know that all tools and appliances are in safe condition before using, move away from tracks upon approach and during passage of trains, and, so far as practicable, prevent the public from walking on tracks or otherwise trespassing on the right-of-way.

Ballast.

Purpose.—Ballast is used for the purpose of securing a solid bearing for the ties, holding them firmly in position and supportng the tracks as uniformly as possible, distributing the trainloads over the roadbed, providing rapid and efficient drainage, and preventing as far as possible the freezing of the roadbed.

Material.—Ballast shall be of broken stone, gravel, slag, cinders, chats, chert, burnt clay, gumbo or disintegrated granite. The selection of the particular kind of ballast to be used shall be determined by the title.

Quality and Size.—Broken stone—Broken stone ballast shall be clean, free from earth and all foreign substances, of the quality and sizes required under the company's specifications for stone ballast.

Quality, Etc., of Gravel.—Gravel ballast shall be of a uniform size, clean and free from fine sand, loam, clay and stones which will disintegrate or cause rough riding track.

Quality, Etc., of Cinders.—The use of cinders as ballast is recommended for the following situations: On branch lines with a light traffic; on sidings and yard tracks near point of production; as subballast in wet, spongy places; in cuts and on fills; as sub-ballast on new work where dumps are settling, and at places where the track heaves from frost. It is recommended that provision be made for wetting down cinders immediately after being drawn.

Quality, Etc., of Burnt Clay.—The material should be black gumbo or other suitable clay free from sand or silt. The suitability of the material should be determined by thorough testing in a small test kiln before establishing a ballast kiln.

The material should be burned hard and thoroughly.

The fuel used should be fresh and clean enough to burn with a clean fire. It is important that a sufficient supply be kept on hand to prevent interruption of the process of burning.

Burning should be done under the supervision of an experienced and competent burner.

Ballast should be allowed to cool before it is loaded out of the pit.

Absorption of water should not exceed 15 per cent by weight.

Depth of Ballast.—The depth and slope of the ballast shall conform to the standard section for the particular kind of ballast to be used.

Preparation of Subgrade.—Track centers and grade lines shall be given by the engineer previous to ballasting track. The subgrade shall be properly prepared for ballast; all unsuitable material above the bottom of the ties removed, and banks widened to retain the ballast and secure good drainage. The track shall then be thrown to line and the ballast delivered.

Open Track, Etc.—Track shall be kept in good line and surface when ballasting, and shall be carefully watched to avoid rail buckling and throwing track out of line.

Mixing Ballast With Old Material.—Care shall be taken in handling ballast to prevent mixing with earth, or with old, unsuitable material between and around the ends of ties, or wasting down the slopes of embankments. Ballast forks should be used exclusively for handling broken stone and slag ballast.

Embankments Not Well Settled.—On embankments that are not well settled the surface of the roadbed shall be raised with suitable material. Material for this purpose shall not be taken from the slopes of the embankments.

Tamping.—Ballast shall be well and thoroughly tamped at each end of the ties, directly under and about 15 in. on each side of the rails. The center shall be filled and lightly tamped.

Tamping picks shall be used for tamping broken stone and slag ballast.

Bonded Rails.—Ballast shall not be allowed to come in contact with rails where bonded. At points where it is impossible to prevent such contact, broken stone or clean gravel ballast shall be used.

Surfacing.—The general surface of track must not be raised without proper authority.

Trimming, Etc.—After ballast is placed it shall be neatly trimmed, and the track accurately gauged and properly surfaced and lined to conform to the standard drawing.

Filling Between Tracks.—The space between double tracks up to the underside of the ties shall be filled with coarse stones and then be leveled off with standard ballast up to the tops of ties.

Heaving, Etc.—When track becomes foul, churns, heaves, or wet spots develop, the bad material shall be removed to the depth and in the manner required to secure drainage and the space filled up with good material.

Batteries.

Batterymen.—Batterymen shall report to, and receive instructions from, the ...... (Title.)

Responsibility.—They shall be responsible for the proper inspection and safe condition of all batteries and connections under their charge.

Batteries (Inspection).—They must inspect all batteries in their districts at least once each week and make renewals as frequently as necessary to maintain constant voltage.

Records.—They must keep detailed records of the performance of batteries, and of the materials used.

Relieving Others.—They must, in case of emergency, render all assistance in their power to the .... (Title) and at other times, when not interfering with their regular duties.

Maintenance of Batteries.—They shall follow the special instructions, and the directions furnished by the different manufacturers, for maintaining batteries.

Care, Etc., of Materials.—They shall be responsible for the proper care and use of tools and materials necessary for the efficient performance of their duties, and shall make requisition to the .... (Title) from time to time, as additional supply becomes necessary.

Changes.—They must not make nor permit any permanent rearrangement or change in wiring or connections without proper authority.

Battery Wells, Etc.—They shall keep all battery wells, chutes, boxes, cupboards and houses neat and clean, and locked when not in use.

Care of Batteries (Protection).—They shall keep batteries at as even a temperature as possible and protected from extreme heat or cold.

Renewing Batteries.—They must not keep more than one cell out of service at one time when renewing track batteries, or more than two cells when renewing main or signal batteries.

Batteries—Jars.—They shall handle jars with care to prevent breaking or disturbing the elements, and keep them clean, bright and free from creeping salts. All cracked or broken jars shall be taken out of service immediately.

Battery Solution.—They must not empty battery solution in streams, on roadbed, ties, bridges, or where the solution may come in contact with wires on top of or under the ground.

Batteries (Jumpers).—They shall use jumpers when removing cells to prevent opening normally closed circuits, except where batteries are connected in multiple.

Scrap.—They shall collect all old scrap zinc, copper and other materials and ship to storekeeper once each month.

Cars Unloading, Etc.

They (track foremen) shall be responsible for the prompt loading, unloading and forwarding of cars containing roadway material. They shall conform to the Master Car Builders' rules governing the loading of material on cars.

Deportment.

General.—Employees must conduct themselves properly at all times. They must be civil and courteous to fellow-employees and patrons of the road. Employees who are dishonest, vicious, quarrelsome or use profane, vulgar or immoral language will be discharged.

Discharging Men.—They shall employ men as the ...... (Title) directs. They must treat employees with consideration, and see that they properly perform their duties. They shall discharge men who are incompetent or neglect their duties, but in no case shall they discharge men without cause. They must keep the required records of the time of their men and of the materials used.

Drainage.

Special attention must be given to the proper drainage of the roadbed for the maintenance of good track. This is essential, and the farther water can be kept away, or the sooner it can be diverted from the roadbed, the better the track will be protected.

Construction.—Ditches shall be constructed in accordance with the standard drawing of the sizes necessary to thoroughly drain the roadbed and afford free flow of all water during heavy rains. The line of the top edges of ditches must be well and neatly formed, and be parallel with and at the standard distance from the rails, except at inlets and outlets, where ditches should diverge from the roadbed to prevent damaging embankments.

Ditches should be drained into natural waterways. At locations where this is impossible or impracticable, special instructions must be obtained from the proper authority previous to starting work.

Washing at Ends of Cuts.—When the roadbed is endangered by water from ditches or other waterways approaching too close thereto, causing washing of the soil, the gullies shall be filled up, and special efforts made to prevent continuance of the wash.

Cross-drains.—Cross-drains shall be installed where necessary. They shall conform to the standard drawing and be placed at the depths and to the grades required to obtain proper drainage.

Surface Ditches.—Surface water should be intercepted by surface ditches on the upper side of cuts when necessary or practicable.

Road Crossings.—Road crossings shall be drained in accordance with the special instructions given by the proper authority in each particular case.

Wet Cuts, Etc.—When side ditches in wet cuts afford insufficient drainage, drain pipes shall be used. The pipes shall be of the quality and dimensions required and shall be laid, as directed, by the proper authority.

Disposition of Earth.—Material taken from ditches or elsewhere must be deposited on the slopes of embankments, below the ballast, and not be put on the tops or slopes of cuts.

Maintenance, Etc.—The construction of ditches or drains, for

public or private use, on lands of the company, must not be permitted except by proper authority.

Adjoining land owners must not be permitted to connect ditches or drains with, or divert water into, the company's ditches or drains without proper authority.

Adjoining land owners must not be allowed to obstruct the company's ditches or drains.

Water must not be diverted through private lands or from its natural channels, along the right-of-way, except by proper authority.

Discussion on Rules and Organization.

Mr. McNab: In regard to this new rule 11, I think this association should not go on record as limiting the range of politeness to be extended by employes of any road. I see here, "Employes must conduct themselves properly at all times. They must be civil and courteous to fellow employes and patrons of the road." It seems to me, if an employe is courteous or civil to a man or a woman, not a patron of the road, they might be induced to become patrons of that road. I think there should be something to take away the limiting of the range of politeness or courtesy. It seems to me it is not right to limit it to the patrons of the road.

C. E. Lindsay (N. Y. C. & H. R.): I quite agree with the views expressed by Mr. McNab. These rules are to be inserted in the manual, and I think they should be expressed in the plainest Anglo-Saxon that we can get. I think that clause might well stop with the word "courteous"—they shall be civil and courteous. I have one other objection, and that is to the opening paragraph, 4, which reads, "employes must exercise care and watchfulness, to prevent injury to themselves, other employes and the public, and to prevent damage to property." I think the word "take" would be better than the word "exercise." I think the words "and watchfulness" are redundant and unnecessary. I think the first part is addressed to the employe and the latter part is addressed to the employer. The word "must," in the last line, should be "will"—will discharge—giving warning to the employe that he will be discharged if he violates the rules.

Jos. O. Osgood (C. R. R. of N. J.): Then the next sentence would read, "employes who are dishonest, vicious, quarrelsome, or use profane, vulgar or immoral language will be discharged."

P. C. Newbegin (B. & A.): It would hardly seem to me that we want to go on record that the employes will be discharged if they use profane language. It is best, in my judgment, to have no rules that are not to be enforced.

Azel Ames (U. S. Block Signal & T. C. Board): I do not think it is proper in any rule of a railway to state, "if you do this, you will be discharged." It is assumed that a man will be discharged for non-obedience to the rules, if that non-obedience is flagrant or frequent enough, but I do not think any specific rule should embody in it the threat that if the man does not obey that particular rule he will be discharged.

Mr. McNab: Mr. President, I think the last clause of this rule should not stand. I think it would require unusual perception to determine what is the degree of vulgarity or dishonesty or any other feature connected with these qualifications. I think that any well-regulated railway will see that employes are discharged if they are guilty of that.

A motion to eliminate the last clause of rule 11 was carried.

A motion to insert a clause in rule 4, saying—"when employes are working on double tracks, they should get off of both tracks when trains are approaching"—was defeated.

Mr. Lindsay: I ask if the committee will omit the words "without proper authority" on the first line of rule 10.

The President: That is satisfactory to the committee.

Prof. S. N. Williams (Cornell College): If it is the intention to shorten the rules, might not the words "civil and" be eliminated, so as to make the rule read, "they must be courteous to fellow employes," etc. Or it might be better to have the rule read, as follows: "Employes must conduct themselves properly at all times, and be courteous to fellow employes and patrons of the road," etc.

The President: That is acceptable to the committee.

Mr. McNab: If these rules are to be incorporated in the manual of recommended practice, I think there should be no ambiguity as to the meaning of any word. A man may compare his watch and put it in his pocket, and do nothing more than that. I think the word "verify" would be a better word to use. I ask the committee if they will accept the word "verify" instead of "compare."

The President: That change is acceptable to the committee.

The convention is open to suggestions from the members on the future work of this committee. It is very useful to the committee to know what the wish of the association is with reference to its work, and along what lines it should proceed. It will be found that this committee has done an immense amount of work during the year. It examined the rules of sixty-one railways, and tabulated and compiled the information, which in itself is a large task. These rules were classified under eight different heads, and conclusions were drawn therefrom.

Mr. Osgood: The eight selected represented a very small portion of the rules examined. We found, after making a record of the rules, that there were certain variations, and we then selected a certain number which seemed best to us, and have submitted them as an appendix.

E. F. Wendt (P. & L. E.): I think this committee is working along a line which will result in much good for railways, and the recommendation which they have submitted is certainly one which should be adopted, and the subjects for next year will be along that line. A number of prominent railways have, at the present time, standard books of rules for the government of Maintenance of Way departments, but such books are not in general use. It seems to me that the committee should continue the good work which has been begun, and produce finally a book of standard rules for the Maintenance of Way department, these rules being of general application.

H. A. Lloyd (Erie): In reading over some of the rules, I notice they have entirely different sets of rules governing the track foremen, the bridge and building foremen, and the signal foremen. Since a lot of clauses and paragraphs are applicable to each one, this makes a voluminous book. It seems to me that could be eliminated.

The President: The committee is formulating its work in the preparation of a general book of rules, and wherever it is possible to make a general rule applicable to all employes, it will compile it as a general rule, so as to avoid repetition.

Signaling and Interlocking.

Seven subjects were assigned, as follows.

(1) Revision of Manual.

(2) Continue investigation of outline and description of a complete and uniform signal system suitable for general adoption, conferring with proper committee of the American Railway Association on the subject.

(3) Revise mechanical interlocking specifications presented in Bulletin 108, and include wrought-iron pipe as well as steel.

(4) Review and resubmit electric interlocking specifications, with statement of the results from experience.

(5) Confer with committee on ties, and make report on the effect of treated and metal ties on track circuits.

(6) Confer with committee on yards and terminals, in regard to capacity of terminal layouts.

(7) Make concise recommendations for next year's work.

The following sub-committees were appointed:

Revision of Manual: Messrs. Ames, Balliet, and Wendt, chairman. Uniform Signal System, Sub-Committee "B": To prepare statement to be submitted to the proper committee of the American Railway Association, Messrs. Stevens and Anthony. Met in Buffalo, April 5, and completed its work. Sub-Committee "J": Elected by the entire committee to represent it when called into further conference by the Committee on Transportation of the American Railway Association, Messrs. Anthony, Clausen, Patenall, Stevens, and Rudd, Chairman. It has not been called. Sub-Committee "C": To report on the indications after the Committee on Transportation has made a decision on the points of difference between the majority and minority as brought out at the last annual meeting, Messrs. Baker, Besler, Cable, Causey, Clausen, Harahan, Ingalls, Scott, Temple, and Rudd, chairman. No meetings. Sub-Committee "A," on Aspects: Messrs. Patenall, Peabody, Stevens, Young, and Anthony, chairman. No meetings.

Mechanical and Electrical Interlocking Specifications: Messrs. Anthony, Patenall, Peabody, Stevens, and Mock, chairman. Met at Chicago, November 14, all members present.

Effect of Treated and Metal Ties on Track Circuits: Messrs. Christofferson, Elliott, Eck, Hovey, Mock, Rhea, and Denney, chairman. No meetings held.

Conference with Committee on Yards and Terminals: Messrs. Balliet, Eck, Peabody, Wendt, Young, and Elliott, chairman. One meeting.

Recommendations for Next Year's Work: Messrs. Ames, Clausen, Denney, and Rudd, chairman. One meeting.

Conference with Committee on Track—Special: Messrs. Ames, Anthony, Elliott, Patenall and Rudd, chairman. Mock afterward substituted for Rudd, as chairman. Two meetings.

Revision of Manual.

Specifications for rubber-covered wire were adopted March, 1909, and are in the Manual. New specifications have been accepted by the Railway Signal Association and sent to letter-ballot for approval.

It has been the policy of this association to let the Railway Signal Association work out details of signal appliances and to adopt only after adoption by the Railway Signal Association. The committee, therefore, offers for the reasons set forth in the report this conclusion: "That the revised specifications for mineral matter rubber compound insulated signal wire be adopted by the association and printed in the Manual."

The changes from present specifications are as follows:

Title has been changed by inserting the words "Mineral Matter Rubber Compound," as being indicative of the general character of the insulation this specification was drawn to cover, and which is, with the exception of certain other compounds, the type of insulation generally required.

In Clause 1, Conductors, the words "weld or joint" have been inserted as more fully explaining the requirement that a conductor is desired that is of one piece as coming from the wire-drawing machines.

Clauses 2 and 3, Rubber Insulation, have been changed to eliminate all references to quantities which are given under Clause 17, and the word "Upriver" has been inserted as specifying the quality of rubber desired, there being a number of grades of Para rubber.

Clause 4, Braiding, has been changed to eliminate the taping, which was useful only as a mechanical protection, and, besides being quite expensive, was not deemed necessary.

Clause 5, Acceptance, is new and is required to enable the purchaser to assure himself as far as practicable before the product has been manufactured that a satisfactory compound will be furnished. This clause is as follows.

"Acceptance.—5. The product of those concerns only will be accepted who have satisfied the purchaser that the requirements of this specification will be complied with. The decision as to the quality of the wire furnished and the acceptance of the same shall be made by the purchaser."

Clauses 6 and 7, Tests, are practically the same as in the present specification, while clause 8, in regard to interpreting the result of the chemical analysis of the compound, is new. The necessity for this clause is obvious if an analysis is made of the compound. Clause 8 is as follows:

"8. At the option of the purchaser the wire, after being tested, shall not be shipped from the factory until an analysis of a sample has been made by a chemist chosen by the purchaser, and the results of such analysis, as interpreted by the purchaser, shall be sufficient ground for rejection should the wire or insulation not conform to the requirements of this specification."

Clause 9, Physical Test of Copper Conductors, has been changed to eliminate all tests except those of elongation and the simple bending tests, these being ample to insure the desired quality of material.

Clause 10, Conductivity Test of Copper, and clause 11, Test of Tinning, are unchanged, while clause 12, requiring an excess of sulphur in the sodium sulphide solution, has been added, as, without this requirement, the test for tinning is valueless. Clause 12 is as follows:

"12. The sodium sulphide solution must contain an excess of sulphur and should have sufficient strength to thoroughly blacken a piece of clean untinned copper wire in five (5) seconds."

Clause 13, Tests of Braiding, is unchanged.

Clauses 14, 15 and 16, Physical Tests of Rubber Insulation, have been changed to specify the rate at which the sample shall be stretched, that the tensile strength per square inch shall be 1,000 instead of 800 pounds, that the test shall be made on a separate sample from that on which the stretching test is made and that the specific gravity shall be not less than 1.75. The increase in

tensile strength is recommended, as, when properly made, a thirty (30) per cent Para rubber compound will meet this requirement, and a compound which contains less quantity of rubber or is of an inferior grade of rubber cannot so readily be made to meet this requirement.

The specific gravity of the rubber compound is specified with the idea of securing a compound of a certain density, and to make more unlikely the use of fillers which have but little body.

Clause 17, Chemical Tests of Rubber Insulation: This clause calls for the thirty (30) per cent of rubber and seven-tenths (0.7) per cent of free sulphur which is required by the present specification, but in the other requirements is practically new and calls for the best practice from a chemical standpoint that could be devised. In connection with chemical analysis, these requirements are regarded as of the greatest importance as insuring to a greater extent than any of the other requirements that a compound will be obtained which will contain the desired quantity of rubber and be of a satisfactory chemical combination.

Clause 18, Electrical Tests of Rubber Insulation, is the same as the present specification, the one-third (1-3) increase in insulation resistance thought advisable by the committee having been opposed by the manufacturers and, at their request, any recommendations on the subject have been postponed with a view to giving time for the manufacturers to demonstrate the correctness of the position taken by them.

Clause 19 has been changed to require that the wire will be arranged in coils for testing to permit of an easy inspection, which is not possible when the wire is wound on a reel.

Clauses 20, 21 and 22, specifying the length of the wire and size of coils, are new, and are required owing to the practice now being followed of making a wire continuous from one binding post to the other and eliminating joints.

Clauses 23, 24 and 25. Packing for Shipment, are new and prescribe the methods to be followed when wire is to be shipped.

Conclusions.

Specifications for cables, weatherproof wire, etc., are closely related to the question of rubber-covered wire, and the committee, although not specifically instructed to do so by the Board of Direction, submits specifications for the following:

(1) Mineral matter rubber compound insulated aerial braided cables for current of 660 volts or less;

(2) Mineral matter rubber compound insulated, lead-covered, armored, submarine cable for 660 or lower voltage service;

(3) Double-braided weatherproof, hard-drawn, copper line wire;

(4) Double-braided, weatherproof, galvanized, B. B. iron line wire;

(5) Double-braided, weatherproof, hard-drawn, copper clad, steel line wire;

(6) Galvanized E. B. B. iron bond wires;

and offers the conclusions that these specifications be adopted by the association and printed in the Manual. The committee further submits the conclusion that the stranding table given on page 156 of Vol. 10, No. 1, of the 1909 proceedings, be changed, and that the following tables for stranded conductors and for flexible conductors be accepted by the association and printed in the Manual:

STRANDED CONDUCTORS.

Approximate Size, B. & S. Gauge.	Number of Strands.	Actual Circular Mills.
2000000	127	2000250
1500000	91	1502592
1000000	91	1003275
900000	91	900900
800000	91	804076
700000	61	698389
600000	61	597861
500000	37	506493
400000	37	400192
350000	37	351722
300000	37	299700
250000	37	248788
0000	19	211470
000	19	167884
00	19	132468
0	19	105450
1	19	84018
2	19	66139
3	7	52274
4	7	41503
5	7	33327
6	7	26047
8	7	16464
9	7	12943
10	7	10374
12	7	6300
14	7	4375
16	7	2527
18-7 No. 26	7	1778
20-7 No. 28	7	1113
21-7 No. 29	7	889
21-7 No. 29	7	700
22-7 No. 30	7	700

FLEXIBLE CONDUCTORS.

Approximate Size, B. & S. Gage.	Number of Strands.	Actual Circular Mills.
0000	37	210900
000	37	168572
00	37	133200
0	37	105894
1	37	83472
2	37	66822
3	19	52364
4	19	41971
5	19	33516
6	19	26011
8	19	17011
9	19	12844
10	19	10051
12	19	6498
14	19	3990
16	19	2508
18-7 No. 26	19	1501

The previous table was confined to 7, 19, 37 and 49 stranding wire with sizes of strands B. & S. G., 11 to 33 inclusive.

The committee finds it desirable that a standard form of report on which the results of physical and electrical tests of wire insulation may be shown should be used, and recommends that the sheet be adopted by the association and printed in the Manual.

Uniform Signal System.

On account of the differences of opinion in the committee, its report on this subject was, by vote of the association, referred back to it in March, 1910, with instructions to confer with the proper committee of the American Railway Association. Such conference was held June 8. A sub-committee of three was appointed by the committee on transportation to further report to the entire committee, it being understood that their conclusions, when arrived at, would be transmitted to us. To date we have received no word from them.

Mechanical and Interlocking Specifications.

The committee reports that the Railway Signal Association has only this year practically completed the specifications for mechanical interlocking, including wrought-iron pipe and electric interlocking, which are shown in Vol. 7 of its Journal for 1910, and the committee will arrange and report complete specifications on both of these subjects (Nos. 3 and 4) in 1911.

Effect of Treated Ties and Metal Ties on Track Circuits.

No meetings were held, as the chairman of the committee on ties advised that that committee would not take up the subject this year, and the committee on wood preservation did not invite the sub-committee to confer with it.

Special Conference with the Committee on Track.

Conferences were held as outlined above, but the entire committee has had no opportunity to pass on this important subject. The committee therefore recommends that if any matters of switch point drilling, spacing of ties, insulation, etc., require consideration after the annual meeting, they be the subject of the joint action by Committees V and X.

The report is signed by A. H. Rudd, Pennsylvania, chairman; L. R. Clausen, C., M. & St. P., vice-chairman; Azel Ames, Train Control Board; C. C. Anthony, Pennsylvania; H. Baker, Q. & C.; H. S. Balliet, N. Y. C. & H. R.; W. G. Besler, C. R. R. of N. J.; W. B. Causey, G. W.; C. A. Christofferson, N. P.; C. E. Denney, L. S. & M. S.; W. J. Eck, Southern; W. H. Elliott, N. Y. C. & H. R.; W. J. Harahan, Erie; M. H. Hovey, Wisconsin Railway Commission; A. S. Ingalls, L. S. & M. S.; J. C. Mock, D. R. T.; F. P. Patenall, B. & O.; J. A. Peabody, C. & N. W.; Frank Rhea, General Electric Company; W. B. Scott, Harriman Lines; Thos. S. Stevens, A., T. & S. F.; H. H. Temple, B. & O.; Edwin F. Wendt, P. & L. E.; J. C. Young, U. P.

Discussion on Signals and Interlocking.

Mr. Ames: There is a misprint in clause 12, on page 134, in describing the covering to be placed over the armoring on submarine cables. It says: "Over the armoring a layer of closely woven jute braiding shall be placed." It should read: "Over the armoring a layer of twisted jute roping should be placed."

B. H. Mann (Mo. Pac.): The question of language in the conclusions as recommended by the committee is important. The first specification we adopted was for mineral matter rubber compound insulated signal wire, and that was adopted as being in accordance with the best practice. It seems, though, the mere fact that it was voted to put that in the manual is no reason why we should leave that wording out, for the reason that in the specification under discussion the conclusion reads: "That the specifications for double braided, weatherproof, hard drawn copper line wire presented as prescribing the best practice, be adopted by the association and printed in the manual." There is a doubt, it seems to me, as to whether the committee means that the double braided, weatherproof, hard drawn copper line wire is the best sort of weatherproofing, or whether they mean this will be specified as the best for the double braided wire. As far as the question of whether the double braided insulation is better than a triple braided insulation, or some other sort of insulation, it does not seem to me that this is the time to take that up, and as far as the adoption of the specification by the Signal Association is concerned, it was put through just as the first conclusion we have adopted, leaving out the words "presented as prescribing the best practice." In that way, we will obviate any possibility of some of the railways inferring that the Maintenance of Way Association has said that the double braided, weatherproof wire is the best for insulation.

Mr. Elliott: The committee has no objection to accepting the suggestion made by Mr. Mann.

Mr. Mann: Is that a typographical error, the use of the BB instead of the "Extra B"?

Mr. Elliott: It should be "BB" in the title, and not "Extra B."

The President: That correction will be made.

Thos. S. Stevens (A., T. & S. F.): I would call attention to the fact that the conclusions are apparently in the wrong place. It is a matter for the secretary to take care of when the report is printed.

The President: This order was submitted by the committee. It is true that the conclusions should be in another place, and should follow the specifications.

Mr. Elliott: The committee asks to eliminate the word "iron" both in the title of the specification and in the second line, as the revised title "double braided, weatherproof, galvanized BB line wire," more correctly specifies the material, which is furnished, and which is used for this purpose.

Mr. Mann: It is understood the committee reports for the adoption of the association that the use of BB weatherproof line wire is the best practice, and a specification for BB iron line wire, or double B galvanized line wire, is desirable, but it does not say that the extra "BB" is the best.

Mr. Elliott: The two things I understand Mr. Mann has in mind are the use of the word "iron," and whether the double B wire is to be preferred to the extra BB. The committee has drawn up a specification for BB line wire, and finds that is the quality of wire most used for the purpose. Another specification would be drawn for extra BB line wire, if it is desired to have such a specification. The specification, in its revised form, eliminating the word "iron," covers the material as furnished and produced commercially. It is in order to prevent any confusion or

difference between the purchaser and the manufacturer that the word "iron" is eliminated. The committee asks permission to eliminate from the second line of the conclusion regarding galvanized E. B. B. bond wires the words: "which calls for the best practice in the furnishing of this product." The committee also asks to eliminate the word "iron," both in the title of this specification, and in the first line of the conclusion, as the revised title, "galvanized E. B. B. bond wires," correctly specifies material which is furnished and used for bond wires.

C. H. Ewing (A. C. R. R.): I would like to call attention to Subject 2. As I understand it, the subject of uniform signal practice is in about the same condition as at the last meeting, with the exception that it has been referred to the American Railway Association committee. It would be of very particular interest if the committee could advise us if they have had any meetings on this subject, and if they have been able to reconcile any of their ideas.

Mr. Elliott: The committee had a conference with the Transportation Committee of the American Railway Association at Niagara Falls last June, and a full hearing and discussion was had. There was a good deal of interest on both sides. I understand the committee of the American Railway Association, having this matter under consideration, has had three or four meetings, and has about concluded its recommendation or decision. At this time we have not had any report as to what that conclusion would be, and until it is finished this committee does not expect to do any further work or take action on the subject. The committee was dismissed with the thanks of the association.

In introducing the report of the committee on Electricity, Chairman Kittredge read the letter which Mr. Berg, a former president, read to the committee at the time the subject was first discussed.

ELECTRICITY.

The following subjects were assigned:

(1) Clearances: G. A. Harwood, R. D. Coombs, A. O. Cunningham, W. S. Murray, George Gibbs, E. B. Katte.

(2) Transmission lines and crossings: R. D. Coombs, A. O. Cunningham, G. A. Harwood, W. S. Murray.

(3) Insulation: J. A. Peabody, R. D. Coombs, W. S. Murray, E. B. Katte.

(4) Maintenance organization: J. B. Austin, Jr., E. P. Dawley, C. E. Lindsay, E. H. McHenry.

(5) Electrolysis: W. W. Drinker, W. S. Kinnear, J. A. Peabody.

(6) Relation to track structures: C. E. Lindsay, E. P. Dawley, E. H. McHenry, J. B. Austin, Jr.

Clearances.

Third-rail clearance line.—Lines beyond which no part of the third-rail structure shall project.

Equipment clearance lines.—Lines beyond which no part of the equipment shall project. Allowance to be made by equipment manufacturer for new equipment for wear on journals and brasses, on axle collars, on rail, on wheels, compression of springs, sagging of center of car, constructional variations, end play, broken springs, etc.

Third-rail gage.—Distance, measured parallel to plane of top of both running rails, between gage of running rail and center line of third rail.

With the adoption of electric traction by railroads using steam equipment, the question of what would constitute safe clearance lines for locating third-rail structures and overhead working conductors immediately presented itself. Most of the roads using steam equipment constructed their third rail so that it would clear the existing equipment, but it was deemed advisable also to fix a limit so that new equipment should not be built to encroach on the space occupied by the third rail. Each road could adopt such equipment clearance lines as would meet its requirements, but this would not prevent complications in regard to interchange of foreign equipment and therefore the American Railway Association appointed a committee to establish recommended clearance lines for both third-rail structures and for equipment.

The study of existing third-rail structures, together with the clearance lines adopted by the American Railway Association, has led the sub-committee to recommend the attached diagram, entitled, "Recommended Clearance Lines for Equipment and Third-Rail Structures, submitted by the Committee on Electricity."

Owing to the overhang of equipment passing around curves, it is advisable to change the lines adopted by the American Railway Association so that the limits shown on attached sheet will be applicable in all cases where the radius of curves is 800 ft. or less.

It has been the experience of steam railways operating a portion of their territory by third rail that, in spite of rigid requirements that equipment be not allowed to extend beyond the line of maximum equipment, cars frequently have to be cut out of service in the electrified territory because of heavy loading, defective springs or other reasons causing the equipment to project beyond the limiting lines. Principally on account of this reason it is thought that the distance of one-half inch between the outline of maximum clearance for structures and the outline of maximum equipment is too small, and that if structures and equipment are allowed to approach so close there will be trouble from fouling in the event of adverse conditions. The sub-committee recommends a distance of 1⅛-in. apart for these two vertical and horizontal lines and a distance varying from $\frac{13}{16}$ in. to $\frac{15}{16}$ in. apart on the inclined part of the diagram which takes care of the side inclines at approaches to the curves, and specifies that "equipment shall under no circumstances project beyond line of maximum equipment except as provided for on curves of 800-ft. radius and less. Structural variation, end play and wear of equipment shall be provided for by the equipment manufacturer inside this line."

Transmission Line Crossing.

The sub-committee has worked in conjunction with the National Electric Light Association and has issued a progress report, which is included in bulletin No. 127. The increase in the number of high-tension transmission lines and the development in the protective regulations enforced by public service corporations and municipal authorities have created a demand for special methods of construction. The attention now given to the subject is due in large part to the presence of occasional lines of relatively high voltage. Any voltage over 250 volts with the currents generally used may cause painful, and, under exceptional conditions, fatal injury. It has, therefore, become necessary to consider all phases of the question as well as all voltages, but as the probability of danger to life or property is mainly confined to the immediate vicinity of the power line and particularly to the space over or under the same, the committee has discussed in this report the so-called "crossings" and not the construction of the power line itself. The more common forms of accidents, together with their causes and results, are discussed. The conditions of loading, cradles, grounding, size and material of wires, insulators, pins, clamping devices, insulated wire, and preservative treatment of cross-arms and poles are dwelt upon in this report, which also includes tables giving the properties of the various forms of wire in common use.

Maintenance Organization.

In connection with the sub-committee on relations to track structures, this sub-committee sent out a circular asking for information concerning the effect of electric traction on the maintenance organization and what changes were made necessary in the track standards; also what had been the effect of electric equipment on the track and steel structures. From a study of the organizations now existing the sub-committee believes that the officer in general charge of maintenance of way of a railway operated by steam or electricity, or both, is, or should be, fully equipped to superintend the maintenance of the various appliances that have been introduced in connection with electrical installation, but should have on his staff an electrical engineer, or be able to consult with one.

Similarly, the division officer in charge of maintenance of way should have on his staff a man with sufficient knowledge of electricity pecular to the installation that will enable him to inspect the work of maintenance performed by the department.

The maintenance of towers or bridges for the support of transmission lines being work of no different nature from that actually performed by the bridge men, there is no reason why it cannot be done under the supervision of the head of the bridges and building forces. The maintenance of the buildings occupied as power houses, sub-stations, battery houses, circuit-breaker houses and cable terminals, is such as is usually done by the building department, and there is no reason for this work being done by any other or by any special department, the only unusual condition being the presence, in some cases, of transmission lines carrying electric current of high voltage, and there is no difficulty in educating men erecting, repairing, painting, etc., around these transmission wires to take the necessary precautions for their safety and for preventing the interruption of the service. The maintenance of aerial cables, wires, suspension bridges of the catenary type composed of wires involves no special knowledge or training that the man in charge of the maintenance of bridges and buildings should not possess. The only care being necessary is to educate the traction linemen actually employed in the work in protecting themselves against personal injuries from high-tension currents and taking the necessary precautions to avoid interruption to the service. This applies with equal force to roads having the third-rail type of contact or the overhead type of contact.

The work of maintaining third rail and appurtenances and track bonds is so closely associated with the work of maintaining track that the section foreman is the logical and proper man to be in charge of all such work on any particular section. The bonds, being usually of the concealed type, necessitate the removal of the joints before they can be inspected or repaired: the third rail is usually supported on the track structure and is in intimate relation with it, so that repairs to the one usually involve repairs to the other, demanding the presence of the section forces, and therefore the section foreman should be the man in control. These remarks apply with equal force to the removing of snow, ice or other obstructions. In yards and at other congested points where there is a number of tracks the work of bond maintenance may be of sufficient amount to warrant having bonders on the section forces, or may be sufficiently great to warrant the organization of an extra gang of bonders, working under an extra gang foreman under the control of the supervisor of track, or, in the event of stretches of territory where the work of bond maintenance would not warrant the employment of a man on each section for that purpose it could be cared for by bonders under the direct supervision of the supervisor of track, these men to work under the immediate supervision of the section foreman while on his territory.

The work of the patrolman, which, on some roads, has been devoted exclusively to the inspection and minor repair of third rail and its appurtenances, is closely associated with that of the trackwalker, and there is no reason why one man could not perform the duties of both and also give such attention as may be necessary to the mechanical inspection of aerial wires and cables, territories being so arranged as to be reasonably within the physical capacity of the patrolman and so as to give inspection sufficiently often to safeguard traffic and avoid delay thereto.

The electrical supervisor above mentioned who reports to the division officer in charge of maintenance is understood to exercise general supervision over all the electrical work done by the supervisor of track and the officer in charge of bridges and buildings, with a view to securing adherence to standards and proper methods of work, principally from an electrical standpoint.

The committee wishes to emphasize one important feature of this proposed organization, namely, the fact that the classification of expense accounts as established by the Interstate Commerce Commission and by various state commissions places in the maintenance of way the expense of maintenance of transmission lines, contact lines, power houses, etc., so that it seems to be exceedingly logical that the actual supervision of the work of maintenance should be done under the supervision of the maintenance of way organization.

In conclusion the sub-committee recommends:

(1) The adoption of the definitions given for Electrical Supervisor, Bonders, Traction Linemen and Patrolmen.

(2) That the work of maintenance should be done as far as possible by the existing maintenance of way organizations,

with such modifications as may be necessary for the special work involved in the electrification.

(3) That a Maintenance of Way Organization, as shown on exhibit attached, will be productive of efficient results.

(4) That these recommendations be printed in the Manual.

Relation to Track Structures.

Bond.—A metallic means for connecting two rails to permit of passage of electric current.

Cable.—A rope composed of wires for the transmission of electricity.

As the sub-committee has not received reports from many of the roads on which electric propulsion has been introduced, it does not feel warranted in drawing conclusions at this time.

Recommendations.—(1) That the definition of bond and cable be adopted. (2) That the committee continue its investigations along the lines outlined in the circular of inquiry.

Conclusions of the Whole Committee.

(1) Definitions.

Third-Rail Clearance Lines.—Lines beyond which no part of the third-rail structure shall project.

Equipment Clearance Lines.—Lines beyond which no part of the equipment shall project. Allowance to be made by equipment manufacture in new equipment for wear on journals and brasses, on axle collars, on rail, on wheels, compression of springs, sagging of center of car, constructional variations, end play, broken springs, etc.

Third-rail Gage.—Distance, measured parallel to plane of top of both running rails, between gage of running rail and center line of third rail.

Electrical Supervisor.—An officer on the division staff qualified to supervise the maintenance of the electrical transmission and working conductors outside of the power station.

Bonders.—Employes qualified to maintain rail and other bonds and their appurtenances for all railroad voltages.

Traction Linemen.—Employes qualified to maintain wires and cables and their appurtenances.

Patrolmen.—Employes qualified to inspect and make minor repairs to track and third-rail structures, cables and wires, and to use hand signals for the protection of trains.

Bond.—A metallic means for connecting two rails to permit of passage of electric current.

Cable.—A rope composed of wires for the transmission of electricity.

(2) The lines shown on diagram B as third-rail clearance lines.

(3) The lines shown on diagram B as equipment clearance lines.

(4) The principle that electric maintenance should, as far as possible, be performed by existing maintenance of way organization, with such modifications as may be necessary.

(5) A maintenance of way organization, shown on diagram A, will be productive of efficient results.

The report is signed by George W. Kittredge, chairman.

Discussion on Electricity.

Mr. Kittredge: I would like to make a few corrections. Under the heading, "definitions," in the conclusions of the whole committee, third rail gage should be the distance between the gage of the running rail and the gage of the third rail, instead of the center line of the third rail. In the definition of "bonders" the last four words, "for all railroad voltages," should be omitted. Those four words properly belong to the next paragraph, which should read: "Employes qualified to maintain wires and cables, and their appurtenances for all railroad voltages." The committee desires to remove from the conclusions recommended for adoption subdivisions 2 and 3; the lines shown on Diagram B as third rail clearances, and the lines shown on Diagram B, as equipment clearance lines, and consider these as reports of progress. It is expected that before the next meeting we can agree with other railway associations on lines that will be satisfactory to all and we think it would be better to have our recommendation of them postponed until the next meeting.

The recommendations of the committee under the head of "definitions" were adopted.

J. C. Mock (Detroit River Tunnel Co.): I should like a little explanation of the definition of third-rail gage. We have been accustomed to use the center line of the third rail. I would like to have explained just what the gage line would be.

Geo. Gibbs (P. T. & T. R.): In trying to define any third rail gage, the clearing point of the third rail, we are working on very close clearance and we are trying to harmonize close dimensions on both sides. The center of the third rail does not fix any point. The third rail may be two or four inches wide, making a difference of an inch, and that is very important.

Robt. Trimble (Penna.): I suggest that the word "line" be omitted, if you are going to change the word "center gage."

Mr. Kittredge: The committee will accept that amendment.

C. C. Anthony (P. R. R.): Mr. President, as this is a definition of third rail gage and it evidently means the gage of the distance between two lines, should not the word "line" appear in both cases in the body of the definition, "between the gage line of the running rail and the gage line of the third rail"? And if that is submitted will it not then be necessary to define the gage line of the third rail?

Mr. Lindsay: I think it will be necessary to adopt the same measuring point on the third rail as on the running rail. The gage is measured at a point one-half inch below the top of the running rail, and that same distance should be adopted on the third rail.

E. B. Katte (N. Y. C.): Because of the very wide difference in the cross section of the third rail, it would not be a very definite line. It would seem to me it should be the distance between the perpendicular line of the third rail and the gage of the running rail.

Mr. Katte: We are interested in the question of clearance, and what we want to know is the space between the vertical plane of the third rail, and the gage line of the running rail. "Gage," I think, is generally understood as being the distance between the verticals.

Mr. Anthony: I would like to emphasize the fact that the question, as it stands, is not correct in that third rail gage line is defined by third rail gage. I cannot see why in the world lines should not appear twice in the gage definition—"gage line of the running rail and the gage line of the third rail."

Mr. Gibbs: Mr. Anthony is entirely correct, but the gage of the track rail is a well-known term, and as we are simply trying to find the measurement between that point and a similar point on the third rail, it will be better defined if we use that term than by any other explanation we could give.

W. M. Camp (Ry. & Eng. Rev.): This is a definition which should be considered pretty carefully. In the gage of track rails, we have the rails right side up, but with the third rail, we may have that rail standing with the head upward or with the head downward. Do we want the third rail gage for the purpose of clearance or is it desired for the purpose of meeting the requirements of the reach of the collector shoe on the car? If the latter is the requirement, then the center of the third rail would be a more desirable point to measure to than the gage line of the head. If the rail is inverted with the head downward, the measurement to the gage side of that head for gage purposes might not be satisfactory, because the base of the rail might be nearer the gage line of the running rail. I would like to ask the chairman what the purpose of this gage is. Is it to determine clearance or to determine the proper distance to the rail for determining the reach of the collector shoe?

Mr. Kittredge: For both purposes. It is essential for one, and essential for the other, too.

Mr. Kittredge: The committee is willing to accept Mr. Anthony's amendment by inserting the word "line" after the word gage, in each case, in the last line of the paragraph.

H. Baldwin (C. C. C. & St. L.): In trying to establish clearance distance why not omit the word "gage" in the second instance? The distance between the gage line of the running rail and the third rail is the question.

Mr. Gibbs: The important point of the third rail is the side of the head which establishes the point where we must place the approach blocks for the side of the inclines on which the shoe will ride. The top corner and side on the contact part of the rail is the important point, and we must fix that. The other parts will take care of themselves.

Mr. Mock: The distance from the standard rail to the gage line of third rail is not fixed by this definition, because of the great differences of rail sections. It seems to me the line should be fixed, and then whatever the form of rail, it must be placed in a certain relation to that.

Mr. Kittredge: There should not be a confusion between the gage line and the clearance line. The gage line of the third rail is not necessarily any clearance line, either for equipment or structures.

Mr. Kenly: I understand the thing to be determined is the third rail clearance lines, not the location of the third rail itself. Then the next thing is to get the third rail location, so that your contact shoe will reach it, and if the center line of that third rail is measured from your gage line, will not that fix the whole thing?

Mr. Lindsay: I think the one great difficulty with the adoption of the center line as the measuring point is the fact that rails are not all symmetrical around the center lines, and where you have an unsymmetrical section, it is difficult to say what is the center line. I think it would be well to drop the track gage as a point from which to measure to the running rail, but to take the center of the track, and say that no part of the running rail above a certain level shall be nearer the center of the track than a certain distance.

Mr. Kittredge: It occurs to me that that is fixing the third rail clearances, and not defining third rail gage. This definition is for the third rail gage, and not clearances.

Mr. Camp: I don't believe we can make this definition suit both clearances and gage. I understand Mr. Kittredge to say that the rail might be at the gage and still not have the desired clearance. To establish clearances, you must measure to the nearest part of that third rail. But if you are going to get it in order to determine the length of the reach of the shoe, then you must use that part of it which comes in contact with the shoe. Unless something more is added, I don't see how the definitions can specify both clearance and gage.

Mr. Trimble: Isn't the point that Mr. Camp raises covered by the definition of third rail clearance lines?

L. S. Rose (C. C. C. & St. L.): As I understand it, definition 1 establishes two lines, one on each side of the track. The third rail would have to be placed within these two lines. The gage line of this third rail will be located according to the third definition.

Mr. Ewing: The matter to be determined is not a standard gage distance. That varies according to the type of rail used. The purpose of this definition is simply to indicate where measurements shall be taken; and perhaps the best measurement can be secured from the center of the rail rather than from the side.

Mr. Gibbs: It is difficult to explain to the association, without diagrams, just what we are after. In laying down a third rail on a track, the shoe must be so adjusted that it has sufficient contact era on the top of the rail or on the bottom of it. That generally means that the third rail shall lap over about two-thirds of the head, if the head is about two and a half inches wide. A very important consideration is getting that shoe, which is hanging down off the rail, up on to the rail when it approaches.

A motion to adopt the definition was carried.

Mr. Porter: In the second definition, "allowance to be" starts the second sentence. Shouldn't that be "shall be" or will be"?

The President: The committee recommends the words "must be" instead of "to be."

Mr. Kittredge: In the fourth definition, the committee would add, "and sub-stations."

The other definitions were accepted as submitted.

Mr. McNab: It seems to me that the word "existing" in paragraph 4 is not necessary. What is existing today may not be existing six or twelve months from now. I think you will cover the same ground if you leave the word "existing" out.

Mr. Kittredge: I do not see that it is essential that that word be taken out. As a rule the installation of electrical operation comes about after the steam operation. It is not necessary that it should, but in the majority of cases it does, and the idea expressed by this is that a new organization for maintenance is not essential. Any existing organization can be developed and expanded and brought up to the point where it can take care of electrical organization as much as steam organization.

A motion to leave out the word "existing" in this paragraph was defeated.

Mr. Kittredge: I suppose there is more opportunity for discussion on conclusion 5 than on any other conclusion that this committee has recommended. The plan that has been outlined in this paragraph is a plan of organization. We don't say it is the only plan, or the best plan. It is a plan which will bring efficient results. The conditions which exist on various railways are very different. It may be necessary to enlarge certain parts of the organization on some roads and on others the duties of three or four persons named here, might be given to one person.

The President: If there is no objection, this will be accepted as information.

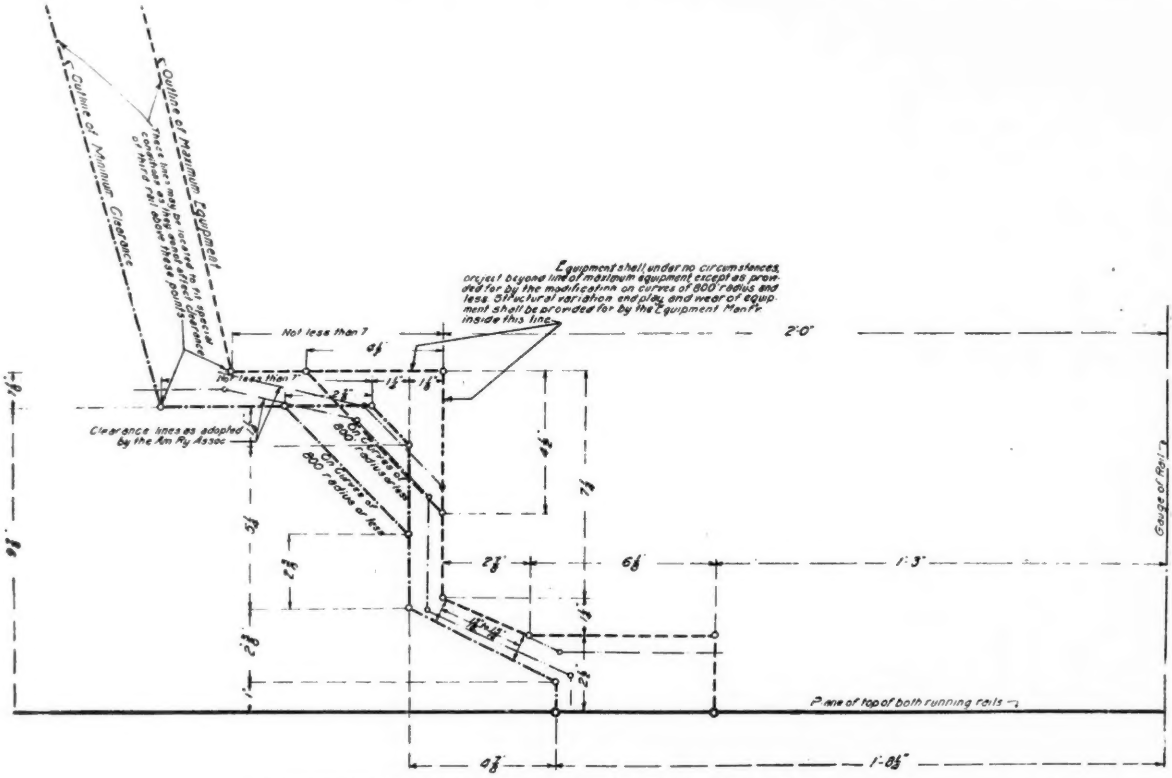
Mr. J. B. Austin, Jr. (L. I. R. R.): We have been talking about third rail organization and not about signal organization. If you want to bring the signal engineer under the electrical engineer, that is a matter for each road to settle for itself.

Mr. Lindsay: The committee purposely eliminated the signal side of the question from its outline of organization. Signaling is, in itself, a great and important specialty, and there is nothing in this outline of organization that interferes in any way with the introduction of the electrical system.

Mr. Mann: In connection with the definition of the electrical supervisor, his duties, are not clear to me. He is qualified to do certain things, but to have these things done, he must go to a co-ordinate officer, the master car builder. He is in a sense responsible under this title of electrical supervisor, but if he wants a wire repaired, and the men who repair the wires are repairing a building, is it necessary for him to go to a division engineer and ask that the master carpenter be instructed to do the work?

Mr. Kittredge: In the definition of electrical supervisor, we have made no attempt to describe his duties. We describe the man. An electrical supervisor on one road may confine his attention to one or two things. On another road he may be a very busy man and not have the title of electrical supervisor, and still be the electrical supervisor.

The committee was excused with the thanks of the association.



Recommended Clearance Lines for Equipment and Third Rail Structures.

BRINE DRIPPINGS FROM REFRIGERATOR CARS.

The Master Car Builders' Association has experimented with a plan which provides that the brine drippings from refrigerator cars be retained in the tanks inside of the cars between icing stations and the tanks emptied at icing stations or points where cars are usually re-iced. Some tests had been made, but they were not satisfactory and were to be continued under extremely high temperature conditions. Accordingly, in August, 1909, the committee conducted an eight-hour day test at the Armour Car Line shops, Chicago. The tests extended from August 4 to August 11, inclusive. The maximum temperature was 94 degrees, between four and five o'clock, August 8. The committee states the tests justify them in making the following recommendations:

"1. All salt-water drippings should be retained in the ice tanks and drained off only at icing stations.

"2. The total capacity of drain opening should not exceed the capacity of traps, and the capacity of drains and traps should be sufficient to release all drippings within the time limit of icing the train.

"3. The mechanism adopted for handling drain valves should be simple and positive, and so designed as to insure closing the valves before hatch plugs can be returned to their places.

"4. Salt drippings should be conducted from ice tanks through the drain valves above described and thence to the outside of cars through the regular traps and drain pipes.

"The packing companies have co-operated with your committee in their investigation, and have expressed their willingness to put into effect the practice recommended by your committee, if these recommendations meet with the approval of the Master Car Builders' Association."

As the above report was approved by the Master Car Builders' Association, June, 1910, your committee is of the opinion that the present status of the subject does not require submitting of further data, showing the damage caused to railroad property because of the present practice, and concludes:

(1) That this association should request the American Railway Association to approve the recommendations of the Master Car Builders' Association as satisfactory.

(2) That this association should request the maintenance of way departments to provide the facilities needed to dispose of the brine drained from cars at the re-icing stations.

The report was signed by: J. C. Mock, chairman; C. H. Cartlidge, C. B. Hoyt.

Discussion on Brine Drippings from Refrigerator Cars.

The President: : I think the thanks of this association and of the railways are due to the M. C. B. association committee, and the committee of this association for finally reaching a conclusion on this matter.

R. G. Kenly (M. & St. L.): I think if we pass this report up to the American Railway Association as having been adopted by this association, we have done our duty and we should not attempt to influence that association by telling them what to do.

The President: The M. C. B. association has already submitted a report to the American Railway Association and it seems to the Chair that it would be proper for us to request prompt action in the matter in order that we may get relief from this burden. The committee of the M. C. B. association did most for it. It seems to the Chair that the conclusions of the committee are very well taken in the matter.

The report was adopted and the committee discharged with the thanks of the association.

YARDS AND TERMINALS.

The subjects assigned were:

(1) Consider revision of Manual.

(2) Development of mechanical handling as a means of promoting rapidity and economy in the handling of freight.

(3) Submit typical track layout for passenger terminal of meduim size, both dead-end and through, and analyze graphically the train capacity of the layout, conferring with Committee on Signals and Interlocking.

(4) Make concise recommendations for next year's work.

RAILWAY ENGINEERING AND MAINTENANCE OF WAY.

Mechanical Handling of Freight.

Such developments as have been made relate almost exclusively to the handling of the cargo at steamship piers in ocean and inland ports. Nothing appears to have been done in the application of mechanical apparatus to ordinary freighthouse work. The cost of freight handling at terminals, however, is entirely out of proportion to the low cost of transportation in modern railway service, and there are possibilities of considerably reducing this terminal cost by the introduction of mechanical appliances.

Design of Passenger Terminals of Medium Size.

This subject has been treated as a continuation or supplement to our report on the subject of passenger terminals in the tenth annual report. Typical track layouts are submitted for both dead-end and through stations that we believe to be susceptible (in their main features) of quite general application. In the design and construction of terminal facilities the object should be to provide such arrangement of tracks as will permit the greatest freedom of movement with the least interference, to the end that incoming and outgoing trains may be handled without serious interruption or delay. In this way will be secured the maximum efficiency of tracks and facilities and the minimum expenditure for installation.

In the operation of terminal stations many, and in some cases most, of the trains handled have to be hauled out of the station after they are unloaded, and placed in a car-cleaning yard. Unless the facilities are ample, they must be moved again after cleaning, and placed on storage tracks. From the storage tracks they are shifted in proper order and placed on a track in the station for outward movement.

If it is necessary at any time to provide for trains arriving or departing (or both) in rapid succession it is very important that the track layout be so arranged that the inbound and the outbound movements will not conflict to any great extent. This will make it possible not only to permit trains in many cases to enter stations at the same time that other trains are departing, but also to fill vacant tracks in the least possible time after outgoing trains have left them. This, in turn, will secure maximum efficiency and will reduce to a minimum the number of tracks in a station to properly handle the business.

The train capacity of tracks depends largely on the facilities provided for rapid handling of the baggage and express matter that is loaded and unloaded while trains are standing at station platform. It follows, therefore, that in order to handle the largest number of heavy trains within a given time these facilities must be the best that conditions will permit, and, if possible, such arrangements should be made as will eliminate interference with the movement of passengers. To this end it is suggested that where it is possible to do so, baggage and express should be received, delivered, and handled below the train floor and raised and lowered by elevators located near the baggage and express cars. This will avoid trucking long distances on platforms used by passengers, to the great discomfort of all concerned and the loss of much valuable time.

There is a very wide variation in the time required to load and unload passengers, baggage and express at stations, depending largely on the character and volume of the business handled by different trains and the facilities provided to insure rapid movement. As a rule the passengers can be loaded on long distance trains in much less time than is required to handle the baggage and express, but with the short distance and suburban trains (on account of the comparatively small amount of baggage and express to be handled) the conditions may be reversed. In any case it is evident that to secure the greatest efficiency in handling a passenger terminal the time required to load passengers and ordinary baggage and do necessary shifting must be considered as the time interval between the departure of trains on any tracks. Therefore, the express, theatrical and other extra heavy baggage should be loaded prior to making up and placing such trains at the passenger platforms.

The operating officers in charge of the large number of stations covered by the investigations place widely divergent estimates of maximum capacity of station tracks, ranging from 2 to 12 trains that could be handled on one track, with an average of 6.5 trains per hour. These figures no doubt represent a very close approximation to the very best results that could be accomplished for a period of time not exceeding one hour and only after preparation had been made, and therefore do not indicate results that could be expected if a continuous performance were required. At the same stations we find that the actual performance is from 2 to 8 trains, with an average of 4.1 trains handled on one track during the busiest hour. It follows, therefore, that under average existing conditions the actual performance during busiest hours is approximately 4 trains per hour on busiest tracks and that a maximum average of 6.5 trains per hour could be accomplished on some tracks. It is to be noted, however, that the stations at which high estimates of efficiency are made either have through tracks or do a large suburban business with light trains.

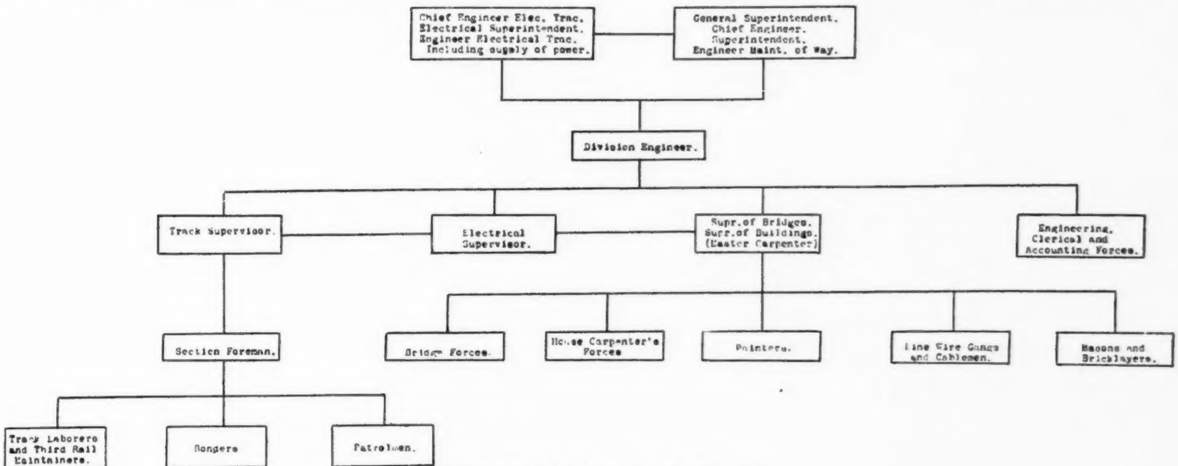
If, however, facilities can be provided that will permit continuous and rapid handling of baggage and express without interference with the movements of passengers, it is believed that results approximating the best estimates can be maintained for much longer periods of time, and that the average of 6.5 trains per hour is well within the limit of efficiency that can be secured. But to do this it is conceded that the station, the track layout and all facilities must be designed in harmony and with the principal object of saving time in handling, and thereby securing results that would ordinarily require a larger installation. With this object in view, we have considered the subject of track layouts at terminal passenger stations, both dead-end and through, and present for your consideration diagrams showing typical layouts embodying and illustrating the suggestions submitted.

Statistics have been gathered showing the general characteristics of the 26 passenger terminals of medium size located in cities in this country, and this information has been tabulated in the accompanying tables. From these it appears that a number of stations at important points are now working close to the limit of their capacity and are showing very creditable efficiency as to operation. But as they are being worked beyond the limit for which they were designed, it is reasonable to suppose that the cost of operation is excessive and that, therefore, some rearrangements would be advantageous, to save time and reduce cost of handling.

In the diagram representing a dead-end station with eight platform tracks, the double-track arrangement at the entrance is preserved to the greatest possible extent, so that the use of station or platform tracks may be made practically continuous. Results are thereby secured closely approximate to the best that could be secured in a station with through tracks and the same length of platforms. It is suggested that where large numbers of passengers arrive in quick succession (as in the case of suburban traffic), full consideration should be given to the question of providing the passage for egress with inclined floors instead of stairs, with the object of increasing capacity and preventing congestion. It is recommended that the grade or fall of such sloping floors be not greater than one in ten (or 10 per cent.), and that all such floors be kept rough at all times, so that slipping may be avoided.

At stations of either type the time required to place a train on a station track, load it, and clear the track for another train is the minimum time interval between department of trains from any one track. Therefore, to secure maximum efficiency the track layout must permit operation practically without interference, as in stations with through tracks, and baggage and express handling must not retard the movement of trains beyond the time needed to properly handle the passengers. In regard to the track layout for a through station, it will be noted that the location is shown at a junction of two double-track roads. A separate station platform is provided for the movement in each direction. All trains making the station stop must be switched from the main track to one side or the other of one of these platforms, thus clearing the main line while the stop is being made. In some station plans a middle platform separates the two pairs of tracks, but it is the opinion of the Committee that it is unnecessary to switch trains across one of the through tracks (as with a three-platform plan). Therefore, the double station or double platform plan was adopted, the two main tracks being continuous and on their proper line through the station.

It will be noted also that a station of this kind has almost unlimited capacity, and, therefore, there is comparativelyy little necessity for much additional trackage. The platforms being of ample size, four ordinary trains can stand at the platform at one time. As these platforms are approached from the bottom, and the baggage and express are handled by elevators, there would be very little interference and the station would be found to have very great capacity.



Maintenance Organization, Electrical Division.

Conclusions.

(1) To avoid excessive cost in providing passenger terminal facilities largely in excess of ordinary requirements, it is imperative that provision be made for economical, efficient and practically continuous operation of the terminal during the periods of greatest activity which may reasonably be expected within a period of, say, ten years. To this end the track layout must be designed to permit incoming and outgoing movements to be made at the same time, without interference, as far as it is possible to arrange this.

(2) At passenger terminals where large quantities of baggage and express must be handled, and it does not appear desirable or expedient to provide intermediate platforms to be used exclusively for this service, it is recommended that (where conditions permit), baggage and express be received, delivered, and handled below the train floor, and raised and lowered by elevators, conveniently located, to avoid interference with the movement of passengers.

The Terminal Officials' Association of Chicago appointed a committee to investigate the handling of interchange traffic and the congestion of a year ago. This committee presented a report at the meeting of that association in September, extracts from which are included in this committee report. In this report the Terminal Officials' Association committee recommended that outside terminal yards supplement the local facilities, and that while several railways and belt lines are providing additional engines and yard facilities, some more radical step is needed than the improvement of these individual facilities.

The report is signed by: F. S. Stevens (P. & R.), chairman; E. R. Tratman (Engineering News), vice-chairman; Hadley Baldwin (C. C. C. & St. L.); W. C. Barrett (B. & O.); G. H. Burgess (D. & H.); L. G. Curtis (B. & O.); A. H. Dakin, Jr., New York, N. Y.; H. T. Douglas, Jr. (W. & L. E.); A. C. Everham (C. H. & D.); M. J. Henoch (L. & N.); H. A. Lane, (B. & O.); L. J. McIntyre (N. P.); B. H. Mann (M. P.); A. Montzheimer (E. J. & E.); W. L. Seddon (S. A. L.); C. H. Spencer (W. T. Co.); A. Swartz (Erie); E. B. Temple (Pennsylvania).

Discussion on Yards and Terminals.

E. R. Loewis (Mich. Cent.): In the definition for export pier will it be acceptable to the committee to say, "a pier," instead of "a covered pier"?

The President: The committee accepts that suggestion.

Prof. Williams (Cornell College): It would seem better to put the word "and" in the definition for coach cleaning yard, making it read "located near terminal station and track should be of sufficient length," etc.

The President: That is acceptable to the committee.

Mr. McNab: I do not see why the word "conveniently" is necessary there. We all know that a coach cleaning yard should be in a convenient location to the terminal station. Why put in the word there? Let the clause read—"The coach cleaning yard should be located near terminal station, etc."

The President: The committee accepts that amendment.

Mr. Rose: Referring to the last paragraph under "outbound freight house," it seems to me the freight could be handled more economically by building the freight house alongside the track, and switching the cars to the freight house, rather than trucking the freight down alley ways at right angles to the freight house.

The president: The committee wishes to retain the definitions now in the manual referring to separating yards and to switching district. It is necessary to include these definitions in the committee's recommendations.

A motion to accept the committee's definitions and recommendations was carried.

Mr. Stevens: The typical track layouts that are submitted with the report on passenger terminal design are intended to illustrate the text of the report, and most of the features that are shown are purely incidental. The principal object for submitting the diagrams is to really state the manner in which it is proposed to get trains in and out promptly. The location of engine houses, water cranes, etc., are incidental features which we do not consider have any particular bearing on this case. They are merely inserted to show what might be done in a terminal of that character, if conditions permitted.

The President: The Chair would like to ask the committee, if in place of ten years, it would not be wise to extend the time of the provision for economical, efficient and practically continuous operation during the periods of greatest activity, which may be reasonably expected to twenty or twenty-five years. Ten years is a short period.

Mr. Stevens: The ten year period was discussed at our meeting and was agreed on as a reasonable time limit to be placed on that.

George W. Kittredge, (N. Y. C. & H. R.): I think a period of ten years is too short a time for which to design a terminal station. I venture that any plant of considerable magnitude, which only provided for a ten years growth would be outgrown before it is completed.

Mr. Stevens: If it is proper, I would like to invite attention to the fact that this report is based on the consideration of passenger terminals of medium size:

Mr. Kittredge: The medium station of today is the large station of tomorrow, and I think my remarks shall apply.

Mr. McNab: I ask Mr. Kittredge when the Grand Central Station improvements were made a few years ago, how long they were figured for. Within my recollection, which does not go so very far back, there have been three changes made in that terminal.

Mr. Kittredge: I am sorry I cannot answer Mr. McNabb as to what my predecessors figured on as to future growth when the last revision was made, but it was not ten years after they made the revision in 1899 or 1900 that they began to rebuild on the present basis. As an example of what growth has taken place since work started on the present terminal, I will say that the first contract with the city provided for the work being completed in five years from the date of beginning, or July 1, 1908. Prior to July 1, 1908, we had to go to the city for an extension of time. We showed the city at that time that so far as excavation and construction work is concerned, we had then completed 108 per cent of all the work contemplated in 1903, when the improvement was begun, but as a matter of fact, it was only about forty per cent of what was then under contemplation.

Mr. McNab: No doubt that is an exceptional case, but I think the committee's report and its recommendation would stand in that respect.

A motion to amend the conclusion to extend the time to twenty years instead of ten years was carried.

Mr. Kittredge: In conclusion 2 why should baggage and express be "received, delivered and handled below the train floor," rather than "below or above?"

Mr. Stevens: The reason "below" is given is because general conditions will permit that construction better, and the head room can be very much less. If the handling of the baggage and express is above the train floor, probably not less than 18 ft. clear would suffice. If it is below 12 ft. is ample, probably 10 ft. would suffice.

Mr. Kittredge: In connection with the terminal at New York, where we have a double deck structure, we find it much more economical to handle baggage and mail and express that comes in on the upper level, above the tracks, and that which comes in on the lower level below the tracks. I think the words "above or below" should be substituted for the word "below."

E. B. Temple (Penna.): I think that is a good suggestion. I am glad to know that you have made the change to twenty years instead of ten years. At the Broad Street station, Philadelphia, we find that the business increases 50 per cent every ten years. For thirty years we have been enlarging, every ten years, and are now up against the problem again.

W. H. Courtenay (L. & N.): The discussion is being based on the largest terminals we have in the United States, and my understanding of these conclusions is that they apply to passenger terminals of medium size. Passenger terminals like that of the New York Central, and the Pennsylvania in New York City, and the Pennsylvania in Broad Street, Philadelphia, are not terminals of medium size. It would seem to me that a terminal of medium size was a terminal in a city of 100,000 people or less. In cities of medium size, where the ground is of reasonable cost, it would be cheaper to handle the baggage on the same level. I do not think the committee should recommend for passenger terminals of medium size that the baggage should be handled on a separate level, because in such cases it is very expensive and hardly justified.

Mr. Temple: We consider that the ideal terminal should be either above the street level or below it, and it does not take any more costly facilities to have the baggage placed on a truck and run on an elevator in the case of such a station, and it is much easier to elevate the baggage to the platform in this manner. If the tracks are in the subway itself, it is as easy to move the baggage from the street level down, as to run it out to the end of the platform. We were dealing more particularly with the ideal station.

Mr. Courtenay: I would like to know what the committee considers the population of the city in which a passenger terminal of medium size would be located.

The President: The committee wishes to ask if you have any alternative conclusion to offer in place of No. 2, which expresses their opinion as to the requirements of a medium sized passenger terminal?

Mr. Courtenay: My opinion is that in passenger terminals of medium size it is better to handle the baggage on the same level. So far as I know, passenger stations of medium size are generally located on the ground surface, neither above nor below. For such a terminal the cheapest way to handle the baggage is to handle it on the same level. If there is much baggage to be handled, it would seem desirable to provide intermediate platforms.

C. H. Spencer, (Wash. Term. Co.): A number of states are agitating the question of the elimination of grade crossings. Some have already passed laws requiring grade crossings to be eliminated. This means that your terminals are bound to be elevated or depressed. In presenting this report the committee presented what they thought was an ideal terminal to meet what may be expected in legislation of this class. Certainly the ideal condition is the terminal that does away with the necessity of grade crossings of any kind.

G. H. Burgess (D. & H.): In the committee's list of 26 terminals that are considered medium sized terminals, 13 are either above or below the street level. It seems to me that that largely answers the question Mr. Courtenay has raised.

C. H. Spencer: I would suggest that the committee consider the question from the standpoint of the amount of business done in the station rather than the population of the city where the station is located. You will notice in the table, that the number of trains originating and departing gives an idea of the amount of business being done in the stations. That is what should govern rather than the size of the city.

Prof. Williams: Would it not be better, since we changed the previous paragraph to twenty years, to take into account the possible growth in business of these terminal stations during the next twenty years and, is it not likely that the business will increae to such an extent as to make it desirable to have this arrangement of the terminal facilities from the present time on?

Mr. Stevens: The committee considered the question of providing facilities very greatly in excess of the present requirements, but considered that would be somewhat extravagant.

Mr. McNab: As brevity with efficiency is desired by this association, I would ask the committee if they would concur in eliminating the words "desirable or" in the second line of conclusion 2.

The President: The committee accepts that.

A motion to adopt the committee's conclusion was carried.

The President: We would be glad to hear from Mr. Condron, a description of the telpher system being installed in the M. K. & T. freight house in St. Louis, Mo.

T. L. Condron, (Com. Eng.): The freight station is designed for both inbound and outbound l. c. l. freight. The building is of structural steel, 400 ft. long by 240 ft. wide, and is built so that the street on the east is about 20 ft. below the street on the west. The lower level of the staion is on the level of the street to the east, or about twenty feet below the level of Broadway, and on this lower level are twelve tracks, 400 ft. long, providing for 120 freight cars of average length. Between the freight cars are twelve 12-foot platforms, and over the platforms are hatchways into the floor above. The second floor on the level of Broadway has four driveways, each 38 ft. wide, running across the entire width of the building, with a platform on each side of the driveway to which teams can back up or drive alongside. The platform

	STATION.	LOCATION.	Type: Through.	Type: Headhouse.	Station Bldg.: Over Tracks.	Station Bldg.: At End of Tracks.	Station Bldg.: Side of Tracks.	Grade of Tracks: At Streets.	Grade of Tracks: Over Streets.	Grade of Tracks: Under Streets.	Through Trains Daily.	Trains Originating.	Trains Terminating.	No. of Trains Handled During Busiest Hour.	No. of Trains Handled on One Track During Busiest Hour.	Est. No. of Trains that Could Be Handled During Busiest Hour.	Est. No. of Trains that Could Be Handled on One Track During Busiest Hour.	Number and Spacing of Tracks.	Number and Width of Platforms.	Length of Platforms.	Height Above Top of Rail.	Are Tracks on Tangent or Curve.	Are Switches Interlocked.
1	Dearborn	Chicago, Ill.		*		*		*			0	53	55	14	3	17	3	10 (see Plan)	See Plan	670′	6″	Tangent	No.
2	D. L. & W.	Hoboken, N. J.		*		*		*			0	127	118	29	5	54	8	14-13′0″ C.-C.	8-20′; 1-17′	700′	6″	Tangent	Yes
3	Erie	Jersey City, N. J.		*		*		*			0	123	126	28	8	33	12	10-15′0″ C.-C.	5-15′	650′-700′	2″	Tangent	Yes
4	Long Isl'd.	Long Island, N. Y.		*		*		*			0	135	134	60	5	65	12	24-24′-0″ C.-C.	9-14′	760′	9″	Tangent	Yes
5	Union	New Orleans, La.		*		*		*			0	11	11	6	2	12	3	4-24′-0″ C.-C.	2-17′	704′	7″	Tangent	Yes
6	Union	Cincinnati, O.		*		*				*	0	69	67	28	4	30	5	8	4-13′ & 15′	1-600′; 3-650′	10″	Tangent	No.
7	Union	Louisville, Ky.		*		*		*			6	24	24	14	3	32	12	6-26′&20′C.-C.	3-17′; 2-11′	450′-600′	6″	Tangent	No.
8	Union	Savannah, Ga.		*		*			*		10	8	8					9-14′to25′C-C.	4-15′; 3-10′	600′	7″	Tangent	Yes
9	Union	Columbus, Ohio	*				*			*	25	34	35	19	4	19	5	8-11′-0″ C.-C.	1-11′; 3-17′	2-678′; 2-774′	8″	Tangent	No.
10	B. & O.	Philadelphia, Pa.	*				*			*	20	14	14	6	3	12	4	6-12′&13′C.-C	2-23′; 1-12′	700′	0″	Tangent	Yes
11	B. & O.	Baltimore, Md.	*				*			*	26	12	6	8	6	12	6	5-12′ C.-C.	Shed Area	426′	0″	Tangent	Yes
12	B. & O.	Baltimore, Md.	*	*		*	*	*		*	37	20	25	6	2	12	3	7-12′&50′C.-C.	3-15′	610′	15″	Tangent	Yes
13	Union	Peoria, Ill.	*				*	*			0	43	39	14	4	78	12	7	1-18′;3-12′;1-6′.	480′	0″	Tangent	No.
14	Union	Troy, N. Y.	*				*	*			57	24	20	14	7	25	10	7-12′ C.-C.	4-12′	3-400′; 1-310′	10″	Tangent	Yes
15	Union	Albany, N. Y.	*				*				88	35	34	17	6	17	6	8	3-28′; 1-27′	650′-850′	6″	Tangent	Yes
16	P. & R. Ry	Reading, Pa.	*				*		*		32	14	14	12	3	30	5		1-20′; 2-15′	1100′	8″	Tangent	Yes
17	Penna. R.R	Harrisburg, Pa.	*				*		*	*	55	47	45	8	5	30	6	8-12′ C. C.	5-37′-22′	765′-860′	7″	Tangent	Yes
18	Union	Birmingham, Ala.	*				*	*			6	20	20					10-12′ C. C.	5-19½′	3-620′; 2-770′	8″	Tangent	Yes
19	C.M.& St.P	Milwaukee, Wis.	*				*				22	30	32	12	3	20	6	5-13′&20′C.-C.	Shed Area	1000′—Max.	0″	Tangent	No.
20	Union	Minneapolis, Minn.	*				*			*	44	30	30	16	2	30	2	6-26′ C. C.	Shed Area	1200′	0″	Tangent	No.
21	Union	Indianapolis, Ind.	*				*	*			46	42	40	30	4	37	5	8	Shed Area		0″	Tangent	
22	Union	Toledo, Ohio	*	*			*			*	43	39	40					13-12′ C.-C.	3-26′		0″	Tangent & Curve.	No.
23	Union	Nashville, Tenn.	*	*	*					*	10	26	26	11	2	15	4	10-20′&28′C-C	5-20′. 4-11′	550′-750′	9½″	Tangent	Yes
24	Union	Richmond, Va.	*	*		*	*		*		10	7	7					9-12′; 23′&13′.	2-8′; 5-14½′	650′-1248′		Tangent	Yes
25	Union	St. Paul, Minn.	*	*		*	*	*			92	46	46	42	5	42	5	14-26′&13′C-C	8-16′	800′	12″	Tangent	No
26	Union	Seattle, Wash.	*	*		*	*			*	6	35	36					11-12′ C.-C.	4-18′	200′	0″	Tangent	No.

Facilities and Data, Medium-Sized Terminal.

space of the second floor is 3 ft. 9 in. above the street level and covers something over one acre of ground. The freight will be received from the wagons that come into the freight house on these platforms, ready to be weighed and distributed by means of overhead telphers, running on mono-rails, to the various hatchways. Likewise freight coming in will be lifted by means of these telphers to the platform level above, and distributed to the wagons. The telphers are carried on I-beam runways suspended from the structural steel framing of the third floor, the story height between the first floor and the third floor being 34 feet; the column spacing in the building is 40 ft. in one direction and 38 ft. in the other. The telphers will pick up the freight which, in the case of small packages, will be loaded on flat boards having small castor wheels under them and suspended from a frame, so that they can be picked up by the hook of the telpher and raised through the hatchways or raised above the team floors, and passed over the area.

The President. The Chair believes that this is the first application of the telpher system to the handling of l. c. l. freight in a freight station in this country, and it will be very interesting to watch the development of this particular installation.

A. W. Thompson (B. & O.): The telpher or Sprague system has been in operation about a year on the Baltimore & Ohio pier in Baltimore, Md. This system is similar to the one just described.

The President: Have you much l. c. l. freight to handle there or is it car load freight?

Mr. Thompson: It is both. The largest percentage is l. c. l. It is quite similar to the business done in an ordinary freight house.

	STATION.	LOCATION.	Method of Making Up and Breaking Up of Trains.	Are Engines Changed on Through Trains.	Are Cars Added or Dropped, and Why.	Special Arrangements For Handling Suburban Traffic.	Method of Handling Express and Baggage.	System of Communication From Dispatcher To Train Conductor.	Distance To Engine House.	Distance To Car Storage Yard.	If Union Station, What Is System of Handling
1	Dearborn	Chicago, Ill.	Switch Engines	No.		None	Trucks	None	5m.	5.6m.	Own'g Co. handles
2	D. L. & W.	Hoboken, N. J.	Sw.Eng.&Gravit	No.		None	Trucks & Cars	Thru Sta. Master	1800′	600′	Not.
3	Erie	Jersey City, N. J.	Sw. &Road Engs	No.		None	Trucks	Semaphores	800′	700′-4500′.	Not.
4	Long Island	Long Island, N. Y.	Sw.&RoadEng's.	No.		None	Sw.Eng.&Trucks	Thru Sta. Master	½m.	½m.	Not.
5	Union	New Orleans, La.		No.		None		Thru DispatchOff.			Not.
6	Union	Cincinnati, Ohio		No.			Trucks	Telegraph			Sep. sta. empl'ees.
7	Union	Louisville, Ky.	Switch Engines	Yes	Sleepers&Diners		Truks & Sw.Eng.	Telegraph	1800′	2800′	
8	Union	Savannah, Ga.	Switch Engines	Yes	Seldom	None	Trucks & Floats.	Telegraph	2&4m.	9300′	
9	Union	Columbus, Ohio	Yard Engines	Yes	As TrafficChange	None	Trucks	Telegraph			
10	B. & O.	Philadelphia, Pa.	Switch Engines	Yes	Diners	None	Trucks	Station Wire	1m.		Not.
11	B. & O.	Baltimore, Md.	Yard Engines	No.	1 Sleeper to N. Y	None	Trucks	Thru Sta. Master	2500′	2500′	Not.
12	B. & O.	Baltimore, Md.	Switch Engines	No.	Occasionally	None	Trucks	Sta. Mas. & Tower	3000′	2500′	Not.
13	Union	Peoria, Ill.		No.		None		ThruDispatch.Off	1½m.	Adj't	Sep. sta. empl'ees.
14	Union	Troy, N. Y.		Yes	No.		Trucks	Messenger	1m.	1m.	Sep. sta. empl'ees.
15	Union	Albany, N. Y.		Yes	Yes, Connections		Trucks and Elev.	None	¾m.	Adj't	
16	P. & R. Ry	Reading, Pa.	Switch Engines	No.	Yes, Connections	None	Trucks & Cars		1m.	Adj't	Not.
17	Penna, R. R.	Harrisburg, Pa.	Switch Engines	Yes	Yes		Trucks and Elev.	Thru Sta. Master	4150′	650′	Not.
18	Union	Birmingham, Ala.	Yard Engines	Yes	Yes, Connections		Trucks and Elev.	Telegraph	½-1m.	½-1m.	Not.
19	C. M. & St.P	Milwaukee, Wis.		Yes	Added; LocalSer.		Trucks and Elev.		2m.	½m.	
20	Union	Minneapolis, Minn.		No.	As Required			Telegraph			
21	Union	Indianapolis, Ind.	Yard Engines	Yes	Yes	None	Trucks	Teleg. & Telephone	½ to 1½m	½ to 1½m*	Sep. sta. empl'ees.
22	Union	Toledo, Ohio		Yes	AsTrafficChang.		Trucks	ThruDispatch. Off.	Adj't	Adj't	
23	Union	Nashville, Tenn.	Switch Engines	Yes	Sleepers & Diners		Trucks	Telegraph	800′	800′	
24	Union	Richmond, Va.	Switch Engines	Yes	Yes		Trucks and Elev.	Messenger	½-3.7m.	½-3.7m.	
25	Union	St. Paul, Minn.		No.	Yes		Trucks and Elev.	Telegraph	½m.	½m.	Sep. sta. empl'ees.
26	Union	Seattle, Wash.		Yes	As Required		Trucks and Elev.		None	1000′	

* Indianapolis.—Car storage yards ½ to 1½ miles distant; except Pullman yard, 600 feet.

Facilities and Data, Medium-Sized Terminals (Continuation of Table Above.)

The committee was dismissed with the thanks of the association.

WOODEN BRIDGES AND TRESTLES.

The work assigned was:

(1) Consider the revision of Manual.

(2) Continue to co-operate with Committee Q of the American Society for Testing Materials, and other associations, in the preparation, revision and adoption of uniform standard specifications for structural timber.

(3) Continue the study of principles and methods of pile-driving, including information on pile-drivers and equipment, analysis of practical experience in pile-driving, the strength of sheet piles, recommended types of equipment, of sheet piles, of concrete piles, and of formulas for bearing power.

(4) Make concise recommendations for next year's work.

The following sub-committees were appointed:

To consider further revisions of the Specifications for Southern Yellow Pine: F. H. Bainbridge.

To consider further revisions of the Specifications for Douglas Fir and Western Hemlock: L. J. Hotchkiss.

Piles and Pile-driving: R. D. Coombs, chairman.

(a) Sheet Piles: C. C. Wentworth, chairman; L. J. Hotchkiss, I. L. Simmons, Hans Ibsen. (b) Details: W. S. Bouton, chairman; J. A. Lahmer. (c) Mechanical Pile Protection: J. A. Lahmer, chairman; F. H. Bainbridge. (d) Pile Records: F. B. Sheetz, chairman; Hans Ibsen. (e) Concrete Piles: P. H. Wilson, chairman; R. D Coombs, J. A. Lahmer, L. J. Hotchkiss. (f) Piledrivers: F. B. Scheetz, chairman; W. S. Bouton, G. R. Talcott. (g) Analysis of Practice: F. H. Bainbridge, chairman; F. E. Bissell, H. S. Jacoby, I. L. Simmons. (h) Bearing Power and Formula: F. E. Bissell, chairman; R. D. Coombs, F. B. Scheetz. (i) Water Jet: G. R. Talcott, chairman; L. J. Hotchkiss, F. B. Scheetz, C. C. Wentworth. (j) Overdriving: L. J. Hotchkiss, chairman; H. S. Jacoby. (k) Enlarged Foot, Screw and Disc Piles: P. H. Wilson.

Revision of Manual.

No revision of the Manual in regard to the specifications for southern pine or for Douglas fir and western hemlock is recommended, as it is considered that these specifications should be given a longer commercial use in order to develop points for possible modifications.

The committee recommends:

Conclusions.

(1) That the Pile Record Form be adopted as a standard.

(2) That the Principles of Practice for Pile-driving be adopted.

(3) That the report on Piles and Pile-driving be received as information.

(4) Piling can be protected against marine wood borers by filling sand between the piles and vitrified clay pipe placed around the piles from a point a foot or two below mud line to the same distance above high tide. The expense is such that it is not advisable to apply this treatment to piling which has not been protected against decay.

The report is signed by: Henry S. Jacoby (Cornell University), chairman; F. H. Bainbridge (C. & N. W.), vice-chairman; F. E. Bissell (civil engineer); W. S. Bouton (B. & O.); R. D. Coombs (consulting engineer); L. J. Hotchkiss (C., B. & Q.); Hans Ibsen (M. C.); J. A. Lahmer (K. C. S.); F. B. Scheetz (K. C. Bridge Co.); I. L. Simmons (C., R. I. & P.); G. R. Talcott (B. & O.); C. C. Wentworth (N. & W.); P. H. Wilson (civil engineer).

Appendix B.

(1) A thorough exploration of the soil by borings, or preliminary test piles, is the most important prerequisite to the design and construction of pile foundations.

(2) The cost of exploration is frequently less than that otherwise required merely to revise the plans of the structures involved, without considering the unnecessary cost of the structures due to lack of information.

(3) Where adequate exploration is omitted, it may result in the entire loss of the structure, or in greatly increased cost.

(4) The proper diameter and length of pile, and the method of driving, depend upon the results of the previous exploration.

(5) Where the soil consists wholly or chiefly of sand, the conditions are most favorable to the use of the water jet.

(6) In harder soils containing gravel the use of the jet may be advantageous, provided sufficient volume and pressure be provided.

(7) In clay it may be economical to bore several holes in the soil with the aid of the jet before driving the pile, thus securing the accurate location of the pile, and its lubrication while being driven.

(8) The water jet should not be attached to the pile but handled separately.

(9) Two jets will often succeed where one fails, in special cases a third jet extending a part of the depth aids materially in keeping loose the material around the pile.

(10) Where the material is of such a porous character that the water from the jets may be dissipated and fail to come up in the immediate vicinity of the pile, the utility of the jet is uncertain, except for a part of the penetration.

(11) A steam or drop hammer should be used in connection with the water jet, and used to test the final rate of penetration.

(12) The use of the water jet is one of the most effective means of avoiding injury to piles by overdriving.

(13) There is danger from overdriving when the hammer begins to bounce, provided the head of the pile is not broomed. Overdriving is also indicated by the bending, kicking or staggering of the pile.

(14) The brooming of the head of a pile dissipates a part, and in some cases all, of the energy due to the fall of the hammer.

(15) The weight of the hammer should be proportioned to the weight of the pile, as well as to the character of the soil to be penetrated.

(16) The steam hammer is more effective than the drop hammer in securing the penetration of a pile without injury, because of the shorter interval between blows.

(17) Where shock to surrounding material is apt to prove detrimental to the structure, the steam hammer should always be used instead of the drop hammer. This is especially true in the case of sheet piling which is intended to prevent the passage of water. In some cases also the jet should not be used.

(18) In general, the resistance of piles, penetrating soft material, which depend solely upon skin friction, is materially increased after a period of rest. This period may be as short as fifteen minutes, and rarely exceeds twelve hours.

(19) In tidal waters the resistance of a pile driven at low tide is increased at high tide on account of the extra compression of the soil.

(20) Where a pile penetrates muck or soft yielding material and bears upon a hard stratum at its foot, its strength should be determined as a column or beam; omitting the resistance, if any, due to skin friction.

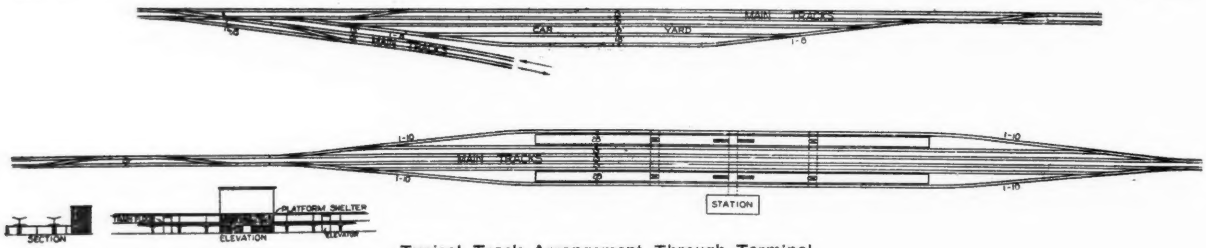
(21) Unless the record of previous experience at the same site is available, the approximate bearing power may be obtained by loading test piles. The results of loading test piles should be used with caution, unless their condition is fairly comparable with that of the piles in the proposed foundation.

(22) In case the piles in a foundation are expected to act as columns the results of loading test piles should not be depended upon unless they are sufficient in number to insure their action in a similar manner, and they are stayed against lateral motion.

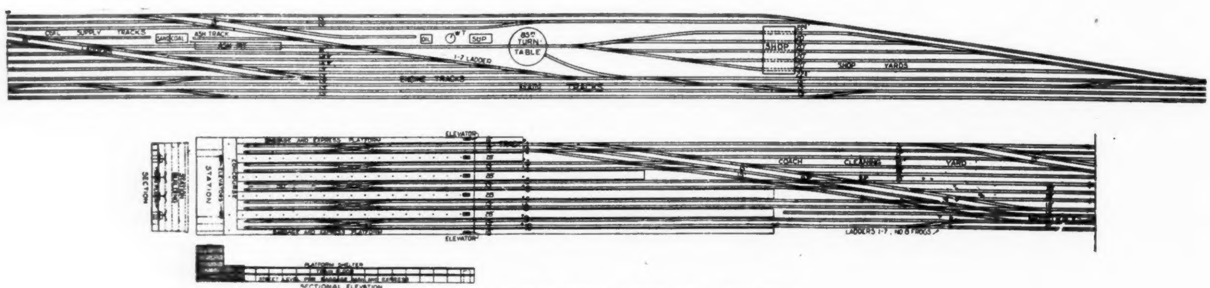
(23) Before testing the penetration of a pile in soft material where its bearing power depends principally, or wholly, upon skin friction, the pile should be allowed to rest for 24 hours after driving.

(24) Where the resistance of piles depends mainly upon skin friction it is possible to diminish the combined strength, or bearing capacity, of a group of piles by driving additional piles within the same area.

(25) Where there is a hard stratum overlying softer material through which the piles are to pass to a firm bearing below, the upper stratum should be removed by dredging or otherwise, provided it would injure the piles to drive through the stratum. The material removed may be replaced if it is needed to provide lateral resistance.



Typical Track Arrangement Through Terminal.



Typical Track Layout, Dead End Terminal.

(26) In general, timber piles may be advantageously pointed to a 3-in. or 4-in. square at the end.

(27) Piles need not be pointed when driven into comparatively soft material.

(28) Shoes should be provided for piles when the driving is very hard, especially in riprap or shale, and should be so constructed as to form an integral part of the pile.

(29) The use of a cap is advantageous in distributing the impact of the hammer more uniformly over the head of the pile, as well as to hold it in position during driving.

(30) The specification relating to the penetration of a pile should be adapted to the soil which the pile is to penetrate.

(31) It is far more important that a proper length of a pile should be put in place without injury than that its penetration should be a specified distance under a given blow, or series of blows.

Discussion on Wooden Bridges and Trestles.

The first conclusion was accepted without discussion.

Hunter McDonald (N. C. & St. L.): I move that we add to paragraph 4 of appendix B "and the purpose for which they are intended."

Mr. Jacoby: The committee accepts that suggestion.

W. H. Courtenay (L. & N. R. R.): I think exception might reasonably be taken to paragraph 7. In the practical operation of driving piles, unless the district is a sandy one, where facilities are ready for the use of a jet, it is quite an expensive matter to get together the apparatus for the jet. In ordinary clay, there is no difficulty in driving a pile sufficiently without jetting, to give all the adequate bearing you can expect a pile to give. A jet does not work very well in clay, and unless the clay is mixed with a very large proportion of sand, I doubt if much good would be obtained by boring holes with a jet for the purpose of placing a pile. In my own experience jets have been used for the purpose of making holes to put piles in for the sole reason that our height of base of rail above the ground was so small that we couldn't get the 70-ft. piles we intended to use in 50 ft. leads, so we had to make holes to put the piles in to get them in the leads, so the hammer could strike them. For that purpose, the cheapest expedient we could devise was to put jets in the ground to start the holes, to get them deep enough to start the pile driver. As soon as that was done, we had no further use for the jet. We have attempted to jet piles in several cases, and have always had difficulty with it. The hole is very likely to close. I do not think this committee should go on record as saying it may be economical to bore several holes in the soil with the aid of the jet, before driving the piles for the purpose of lubricating the piles going down. I do not believe those things would be necessary in order to satisfactorily drive piles in clay soil.

L. J. Hotchkiss (C., B. & Q.): The paragraph in question refers more particularly to the driving of concrete piles. I havve seen several cases myself where it was quite difficult to drive the piles without the jets, without battering up the heads of the piles, but by using the jet as mentioned in this paragraph, the piles went down without any particular difficulty. They went straight and they were got down to a penetration that could not have been reached without the use of the jet. This particular method would only apply in certain kinds of clay, clay with a certain amount of sand or loam. If it were a very stiff clay, the jet would not penetrate. I know since we have been driving concrete piles on the C., B. & Q. we have gotten into the use of the jet to an extent we never have before, and we can get piles down more economically and quickly with the jet than ever before. We have not used it very much in driving wooden piles.

W. F. Steffens (B. & A.): The committee has limited paragraph 7 to boring holes with the water jet. Another case may arise. There is a quality of soil in North Carolina through which it is almost impossible to drive piles. In that soil the use of an earth or clay auger would be advisable. The material so loosened can be removed, leaving a cavity into which the pile can be dropped and then seated, perhaps, with a hammer. I have in mind a case where the use of the jet was advised as a lubricating method and the auger produced a result the committee is seeking to produce entirely by the water jet.

The President: Do you recommend amending paragraph 7 by the addition of your suggestion?

Mr. Steffens: I will offer that to the committee as a suggestion.

Mr. Cartlidge: Such an important matter as that to which our attention has been called should be considered by the committee, and some additional statement brought in later to apply particularly to such a case. I would prefer that the committee bring in a supplementary statement next year.

The President: Is that satisfactory, Mr. Steffens?

Mr. Steffens: I think that would be more desirable.

Mr. Courtenay: I think paragraph 8 is a little too sweeping. On the L. & N. we are now driving piles 100 ft. long through 55 ft. of water. The bottom is sand. We get the piles down very satisfactorily with the aid of a jet to a depth of about 10 ft., and then we strike a stratum of hard material, and we have great difficulty in getting it through. The current is exceedingly strong there—it is tidal current, first north and then south, depending on whether the tide is running in or out. In the case which I cite, I think it would be impossible to jet the piles without the jet being attached to the piles. The current is so swift in the water that a deep-sea diver can't hold himself to the pile without being practically chained to it. In many places, where there is occasion to jet piles down, the jet pipe must necessarily be attached to the pile. Otherwise the two would become to widely separated the jet would do no good.

H. B. Dick (B. & O. S. W.): It used to be the practice on the construction of government jetties to attach the galvanized iron pipe, one to either side of the pile, and a flexible rubber hose was connected from the top of the pipe to the pump. That seemed to be the only successful way in which they could put down piles in sand.

Mr. Hotchkiss: My personal experience with the jet and the pile has been that the jet caught so fast you could not get it down. I remember in one case where the jet was broken.

Mr. Courtenay: We use wrought iron pipe attached to the pile with staples. It would be impossible in 50 ft. of water, with a swift current, to sink a pile with a jet except by attaching the jet and the jet pipe to the pile.

Mr. Hotchkiss: If we could say in this paragraph under consideration that the water jet should not be rigidly attached to the pile, I think that might meet the condition.

Mr. Courtenay: As this matter is general, I think it best to omit No. 8.

Mr. Steffens: What would happen in the case of a concrete pile, cast with the jet hole in the middle. Would the jet be attached on the outside?

Mr. Jacoby: I think there is more difficulty in the jet clogging when it is a part of the pile than in any other case, and certainly the trend of present practice is to handle the jet separately.

Mr. Courtenay: I move No. 8 be modified to read: "water jet should not be attached to the pile, and shoud be handled separately when piles are driven in dry ground, but not when they are driven through water."

Mr. Jacoby: Would not Mr. Courtenay's idea be satisfied if we should say "in general the water jets should not be attached to the pile, but handled separately"?

Mr. Courtenay: I have no objection to that.

Mr. Jacoby: The Committee will insert the words "in general."

Mr. Courtenay: I would suggest the elimination of the words "provided the head of the pile is not broomed," in paragraph 13. Piles may be damaged by over-driving when heads are broomed as well as otherwise.

Mr. Jacoby: The idea is that if the head is allowed to be broomed the effect of the hammer then becomes lost in large part and the bouncing of the hammer will not indicate any injury in any other part of the pile. It is true, in many cases, that the brooming of the head of the pile indicates also that the driving should be stopped, but the rapidity with which the brooming develops and other indications should show to the one in charge what the conditions really are.

Mr. Courtenay: I think those words are misleading. I have seen piles absolutely broken when their heads were broomed, and as a general proposition I would say that when the heads are badly broomed, you may expect more damage has been done to the piles than when the heads are not broomed. On driving piles on several occasions, I have had to take them out. I have found them badly broken in a variety of ways, and the heads were broomed.

E. H. Fitzhugh (G. T. Ry.): It is almost the universal custom in driving piles now to use a cap, and when the cap is used, there is no brooming.

Mr. Courtenay: We drive many thousand piles a year and we don't cap them, we ring or band them.

A motion to eliminate the words: "provided the head of the pile is not broomed," in paragraph 13, was carried.

Mr. Loweth: Referring to paragraph 15, I do not see how we can readjust the weight of the hammer every time we have a different length of pile. I suggest that we modify that to read, "the weight or the drop of the hammer."

The President: That is satisfactory to the committee.

Mr. Jacoby: The committee desires to change the numerals in paragraph 26 from 3 in. or 4 in. to 4 in. or 6 in., because a square of 3 in. is too small.

Mr. Courtenay: I would like to see paragraph 26 eliminated. If a pile could be driven without an iron shoe, I would not advocate pointing them at all. Personally, I am pretty suspicious of piles that are driven with an iron shoe. I think a large proportion of them are damaged.

A. J. Himes (N. Y. C. & St. L.): I have driven piles through the material in the beds of streams in Pennsylvania that were full of large pieces of flat rock and boulders without the use of shoes, without any difficulty.

J. B. Jenkins (B. & O. R. R.): I have often found pointing very advantageous. I have made it a practice to drive them without pointing when I could. Frequently it has been difficult to get them in at all without pointing.

E. B. Temple (Penn.): In hard material piles should be pointed or they may split at the lower end and may not drive safe.

H. D. Porter (B. & L. E.): If you eliminate paragraph 26, I am afraid it will give the impression that this convention does not believe in pointing piles. Where you are driving piles into soil that is broken up you can get them to go the way you want them to go better by pointing them, as they will not be deflected by small stones or hardened material. Where we drive piles in an old road bed we point them, as a rule, and in a great many cases use steel points.

A. F. Robinson (A. T. & S. F.): There are many places where there are boulders and cinders and it is almost impossible to drive a pile unless it is pointed. If we cut out the paragraph about pointing our piles, then we will have to modify the paragraph covering the shoe which almost necessarily means the pile must be sharpened.

R. G. Kenly (M. & St. L.): There are certain times when piles should be pointed, and I move as an amendment to Mr. Courtenay's motion that the two words "in general" be omitted from that paragraph and let the latter part of the rule stand as it is.

Mr. Porter: If we say that piles may be advantageously pointed to a 4-in. or 6-in. square at the end, you indicate that that can be done under any and all circumstances, and I do not think any one is trying to advocate that. There must be some modifying expression in place of "in general" without saying "timber piles may be advantageously pointed."

J. P. Snow (B. & M.): Let Mr. Kenly change his amendment so we can put "in some cases," and allow the word "advantageously" to remain.

Mr. Kenly: That is satisfactory, but I do not see the necessity for it.

The amendment to make the paragraph read "timber piles may be advantageously pointed in some cases to a 3-inch or 4-inch square at the end" was adopted.

William McNab: I ask the committee what they mean by using the word "comparatively" in that clause? Their idea of comparatively may be different from ours. If it has any meaning it is all right. If it has no meaning, I move to strike it out.

Prof. Jacoby: This is quite a large country and the soil conditions certainly vary very considerably, and the interpretation of a word like "comparatively" must have considerable latitude in itself.

Mr. McNab: The word "comparatively" is all right for the present moment, but when it appears in our Manual and comes before

us in print we do not know what the committee's meaning of comparatively was, and you can get the same meaning in this clause if you leave out the word.

The President: The committee is willing to accept your suggestion, Mr. McNab.

Mr. McNab: Is clause 29 necessary? Is it necessary to tell the association that the use of a cap is advantageous?

Prof. Jacoby: I think it may fairly be said without any reflection upon the engineering profession that the advantage of the use of a cap is not adequately appreciated throughout the entire country. I might refer to one instance in which a large number of the very finest long-leaf yellow pine piles were to be driven in a certain location. Rings were employed and the results were not satisfactory and then the cap was used. At first, in order to see whether the cap would be of special value, a thin plate was placed on the pole and it was found the piles could be gotten into position without apparent injury, which, without the plate, could not be done. The cap was sent for and used with entire satisfaction.

Mr. McNab: I move that clause 29 be eliminated as superfluous to the report.

Mr. Stevens: It may be pertinent to remark that I have seen piles driven by the use of caps of thin boards of soft wood, where it was absolutely impossible to force them down by the use of rings. The piles would split in spite of the rings, and with the use of caps of soft wood the pipes would drive without any apparent injury. As a general proposition the piles will drive better with a cap of soft wood across the top of the pile than rings.

Mr. Kittredge: I would amend Mr. McNab's motion and retain the paragraph in this form: "The use of a cap is sometimes advantageous."

L. J. Hotchkiss (C. B. & Q.): In this question we are considering not only the driving of timber piles with which we are all familiar, but the driving of concrete piles as well, with which many of us perhaps are not familiar. There is no way of driving a concrete pile without a cap unless you want to smash it to pieces.

The amendment was put to a vote and was not agreed to.

Hunter McDonald, (N. C. & St. L.): I move that the word "need" in paragraph 27 be stricken out and the word "should" be substituted in its place. The reason is in No. 20 we are told a pile driven in soft material must be treated as a column and nothing is said about how much power you figure on for the column.

The President: The committee accepts your suggestion changing the word "need" to "should."

Mr. Himes: We use pile foundations and permit the concrete to rest directly on the piles and to cover a situation of that sort I would suggest that we say "Where masonry is to bear directly on the piles such portions of the piles as may have been injured by contact with the hammer should be removed."

The President: That matter will be considered by the committee and reported on next year.

The principles of practice for pile driving included in conclusion 2 were adopted.

G. D. Brooke (B. & O.): I would like to go back to the "pile record form." To bring this form into conformity with the form of the Committee on Records and Accounts, it should be headed with the letters A. B. and C. R. R. and with the size of the sheet stated.

The President: The committee accepts that suggestion.

Section 3 of the conclusions was received as information without discussion.

H. A. Lloyd (Erie): Instead of adopting conclusion 4, I move that we accept it as information. It may or may not be true. I think it is just as valuable for the public at large and this association if it is adopted for information.

The motion was carried.

The committee was dismissed with the thanks of the association.

IRON AND STEEL STRUCTURES.

The subjects assigned were:

(1) Revision of Manual.

(2) Report findings on effect of impact on bridges.

(3) Recommend specifications for bridge erection.

(4) Report on secondary stresses.

(5) Report on influence of theory, experiment and experience on bridge design.

(6) Rules for instruction and guidance of inspectors in mill, shop and field.

(7) Make concise recommendations for next year's work.

(8) Make definition of the word "culvert" as distinguished from "bridge."

In addition, the chairman was advised by the board of direction to hold a joint meeting with the Roadway Committee for the purpose of reconciling the specifications for clearances in bridges and tunnels. This committee reported to the board that it would recommend the insertion, in paragraph 2 of the specifications for Iron and Steel Structures as printed in the edition of 1910, after the word diagram in the second line, the following, "the height of rail shall, in all cases, be assumed as 6 in."

In the case of subject (1) the committee has no changes to recommend, except to correct minor typographical errors. In appendix "A" will be found a report by the chairman of the sub-committee on Impact. In appendix "B" are submitted specifications for bridge erection. In Appendix "C" is a report from the sub-committee on Impact, concerning secondary stresses.

The time at the disposal of the committee has not been sufficient to make a proper report on the other subjects put before it, and it is requested that they be referred back to the committee for further consideration.

With regard to next year's work, your committee would suggest the employment of a reporter on subjects connected with design and maintenance of steel structures, whose duty it will be to collate reports of prime interest and report them to the committee as information, which, after being considered and passed upon may be laid before the Association to be printed in bulletins, so as to be accessible to the membership. The committee recommends that a study of the design of large columns be taken up, and suggests that collaboration with an exisitng joint committee appointed for the same purpose, would, perhaps, bring about valuable results.

Conclusion.

The committee recommends the adoption of the specifications for bridge erection for publication in the Manual.

The report is signed by: C. H. Cartlidge (C. B. & Q.), chairman; A. J. Himes (N. Y. C. & St. L.), vice-chairman; J. A. Bohland (Gt. Nor.); Charles Chandler (C. G. W.); C. L. Crandall, professor railway engineering, Cornell University; J. E. Greiner, consulting engineer, Baltimore; B. W. Guppy (B. & M.); Charles M. Mills, consulting engineer, New York; C. N. Monsarrat (C. P.); C. D. Purdon (St. L. S. W.); A. F. Robinson (A. T. & S. F.); C. C. Schneider, consulting engineer, Philadelphia; I. F. Stern (C. & N. W.); F. E. Turneaure, dean of College of Engineering, University of Wisconsin; J. R. Worcester, consulting engineer, Boston.

Appendix A.

Impact Tests.

Organization.—The importance of the subject of Impact and the lack of adequate information relating to it has been the cause of frequent discussion in the association, and especially in its committee on Iron and Steel Structures. Funds were provided by the railways for a series of tests on structures in service, with the special object of studying the effect of moving loads on such structures. Experiments were conducted in the field during the seasons of 1907 and 1908, and the data from these field tests have been worked up in this report.

Instruments.—The instrument used was designed especially for these tests by the chairman of the sub-committee, and was described at the annual meeting of the Association in 1907.

Test Trains.—The test train used in each case was made up of a selected type of locomotive followed generaly by a sufficient number of loaded cars to cover the span. By the arrangement adopted speeds of 60 miles per hour or over were generally obtained, even with freight locomotives.

General Method of Conducting the Tests.—In the case of truss bridges it was the aim of the committee to secure data relative to the deflection at or near the center of the span, and the deformations in all the various kinds of members. With the 12 extensometers in use it was possible to cover the various kinds of members reasonably well with a comparatively few changes of instruments. Generally the tests on the upper and lower chords were confined to one panel, but in most cases at least two of the eye-bars composing a chord member were tested. The same thing is true of diagonal members composed of eye-bars. In carrying out the tests the train was headed in the more favorable direction for speed, and was moved back and forth over the structure at various rates of speed. Such speeds were selected as to cover fairly the range from about 20 miles per hour to the maximum attainable. A few movements were made at from 10 to 15 miles per hour. Little difference was noted in the results at various speeds below 15 miles per hour, and, in general, the results at 10 miles per hour may be considered as practically equal to static stresses. The speed of the train was determined by the use of stop-watches and signals made by observers stationed at the ends of a 500-foot base line. (In the case of very high speeds a 1,000-foot base line was used.) The locomotive was generally working steam when crossing the span, but in some cases it was not. Differences in this respect caused no noticeable differences in results, so far as the field observers were able to judge, although this point was considered mainly with respect to the higher speeds.

Results.

Causes of Impact in General.—The following may be enumerated as the chief factors in causing impact: (1) unbalanced locomotive drivers; (2) rough and uneven track; (3) flat or irregular wheels; (4) eccentric wheels; (5) rapidity of application of load; (6) deflection of beams and stringers, giving rise to variations in the action of the vertical load.

The term "impact" is here used to include any effect of the moving load which results in stresses exceeding the static stresses. Where caused by open joints or rough or flat wheels, this impact is more or less of the nature of a "blow" on the structure; but where caused by the other factors mentioned, it amounts in effect to a varying load or a series of impulses acting upon the structure. In either case the result is to produce deflections and stresses in excess of the static values, such excess of stress being commonly called "impact" stress, or simply "impact."

The experiments obtained in these tests as well as the results obtained in former tests indicate that with track and rolling stock in good condition the main cause of impact is the unbalanced condition of the drivers of the ordinary locomotive. The result aimed at by the mechanical departments is to so counterweigh the wheels as to secure a reasonable compromise between the effect of the rotating parts and the reciprocating parts. This requires the use of counterweights considerably in excess of the amount necessary to balance the rotating parts. So far as the vertical effect on the track is concerned the reciprocating parts are of little influence, but by whatever amount the rotating parts are overbalanced, just so far will there be a variation in pressure on the rail, due to the centrifugal force of such overbalance.

In consequence of the action of these centrifugal forces during the passage of a train, the load acting upon the bridge is a varying one. It varies with each rotation of the driver, and thus acts as a series of impulses tending to set the structure into vibration. In the case of short span bridges these impulses will be repeated only two or three times during the passage of the locomotive, but in the case of long span bridges they will be repeated many times. If now these impulses correspond in period with the normal rate of vibration of the loaded structure, the effect will be cumulative and the vibrations will be greatly increased. Such cumulative effect cannot occur for bridges of very short span length, as the normal rate of vibration of such structures is higher than the rate of rotation of the driver at the highest practicable speeds. It may and frequently does occur in structures of span lengths as low as 75 feet, and sometimes less. The speed at which the impulses here discussed show a cumulative effect may be termed the critical speed. This is discussed more fully in following paragraphs.

Other causes of impact are less readily studied than that of locomotive counterbalance. The condition of track and wheels can be defined in rough general terms only. The effects of these elements, as shown by the tests, were also in most cases such as to make it difficult to express them quantitatively. In same cases the behavior of the loaded cars was such as to cause large impact.

Time of Vibration of Bridges.—A theoretical deduction of a convenient formula which expresses the time of vibration of a loaded bridge in terms of weight of structure and its load, and the static deflection due to the live load will give

$$T = \sqrt{\frac{w + p}{p} \times d},$$

in which T = time of vibration of loaded structure in seconds.
w = dead load per foot, assumed as uniform;
p = live load per foot, assumed as uniform;
d = static deflection in feet due to load p, as determined by direct measurement.

Critical Speeds.—The speed of the train which will produce cumulative vibration, as described above, depends on the natural rate of the loaded structure and the diameter of the locomotive drivers. During the passage of a train the total weight on the structure varies to a considerable extent and hence the normal rate of vibration of the structure also varies. Exact agreement, therefore, between driver rotation and vibration period of the structure will exist only for a short time, and hence the cumulative effect will not continue during the passage of the locomotive entirely across a long span structure. The results show clearly the importance and significance of critical speed on all bridges exceeding about 100 ft. in span length. In all such spans it was found that the excess of deflection or stress at high speeds, over the static effects, was due almost wholly to cumulative vibrations, produced at or near this critical speed.

Law of Impact at Critical Speed.—A theoretical ananlysis of the ideal case of the effect of a rotating weight on the deflection of a beam when such rotation is in phase with the vibration period of the beam itself and their producing cumulative effect on the amplitude of deflection due to the centrifugal force of such rotating weight is given by the expression $x = 2\pi n \frac{Gr}{2W}$, in which G=weight of arm, r=arm of rotating body, W=weight of beam, assumed as concentrated at the center, and n=number of revolutions of weight from beginning of motion. The effect of friction or other resistance in absorbing the energy is not taken into account in this theoretical analysis.

The case of a bridge supporting a rolling load consisting of unbalanced wheels is somewhat similar to the theoretical case here analyzed. The masses are distributed instead of being concentrated and the absorption of energy prevents the development of vibration to the extent assumed by the theory, but the relations brought out in the analysis may be useful in interpreting results. Where the rotating wheels synchronize with the natural period of vibration of the loaded structure, then the vibrations will be cumulative somewhat as assumed in this analysis.

We would then conclude that the amplitude of vibration in such a case would be proportional to the moment of the counterbalance and inversely proportional to the weight of the loaded structure. Such vibrations would also increase in amplitude with the number (n) of impulses due to the rotating weight. Obviously the amplitude will not increase indefinitely as the impulses are repeated, but will soon reach a maximum limit where the energy absorbed balances the energy applied by the rotating body.

Maximum Impact Percentages for Truss Spans.—While the individual results vary somewhat, it is thought that an average value for the main truss members will be more significant than the maximum obtained from any one. The extensometer measurements are affected more or less by secondary stresses, and the instruments themselves are not quite as reliable as the deflectometer, so that on the whole, an average value for these main truss members was considered to be a fair measure of maximum impact for all similar members. It will be seen that the impact values determined from these main members are somewhat greater than the values determined from the deflection records. This is to be expected, partly on account of the effect of secondary stresses, and partly on account of the fact that the deflection itself represents in a measure an average of all of the truss members, and should be somewhat less than the average of a few members.

Effect of Position of Counterbalance.—It is not to be expected that the exact position of counterbalance would have any appreciable effect on spans of any considerable length; but on short-span girders, whose length does not exceed two or three times the circumference of a driver, it would seem that there would be an appreciable difference in impact whether the counterbalance happened to be down or up at the time when the drivers were centrally located on the span.

A marked tendency to give the maximum impact when the counterbalance was in its lowest position was noted, although the variations due to other causes are so great as to mask this effect to a large extent.

Effect of Speed in Application of Load.—Assuming the track perfectly smooth and all of the rotating parts perfectly balanced, the effect of a load moving over a structure at a high rate of speed depends wholly upon the vertical curvature of the track and the effect which this curvature has upon the path over which the center of gravity of the load travels. If the load causes the structure to deflect so that the curvature of the track is concave upward, the presure of the load upon the bridge will be in excess of its weight by reason of the centrifugal force caused by such curvature. If the track has an initial camber so that when the load passes over the structure the deflection produced is just sufficient to bring the track into a straight line, then there would be no centrifugal force developed and the pressure of load upon the track will be constant and exactly equal to the static load. The impact in that case will be zero.

If we assume the track originally straight and absolutely rigid, the amount of impact or centrifugal force resulting from the deflection of the structure can be approximately determined on theoretical grounds. Such an analysis has been made by Dr. H. Zimmerman for the case of a single rolling load, and a formula which is very closely approximate to his exact formula is as follows:

$$F = P\frac{1}{gl^2/16v^2d - 3}$$

n which F=centrifugal force, P=weight of rolling load, v=velocity in feet per second, d=deflection of structure and l=span length.

Considering the fact that for spans or any considerable length the track is cambered, and the abutments not rigid, we may conclude on theoretical grounds that the impact due to speed of application for spans greater than 50 ft. is of no consequence.

The experimental data with reference to this point are very difficult to obtain by reason of other elements which are always present. The results obtained from balanced compound locomotives and electric locomotives are, however, very significant and indicate that under very favorable conditions as to track and rolling loads the impact is of very little consequence even for short spans.

Effect of Rough Track—The effect of low or open joints in the track was directly noticeable on stringers and short span girders, and sometimes on floor beams and hip verticals where the rail joints were near the floor beam. It was not noticeable on main truss members or long span girders. The effect produced was, however, very difficult to determine quantitively. Under these conditions the extensometers were so jarred and shaken up as to make the diagrams unreliable.

Effect of Design.—The most noticeable effect of differences in design is to be seen in the results obtained on stringers and floor beams. The extreme condition of rigidity is illustrated in the results obtained in bridge No. 5 where the rail was supported on steel channels riveted directly on closely spaced crossbeams, and these in turn into the lower chord of the truss. No observations were here made on the crossbeams but the records obtained on hip verticals indicate a very severe jarring effect transmitted from the rail into the floor system. Many similar results were obtained with the ordinary open floor where the stringer spacing was such as to bring the rail nearly over the stringer. In this case the ties would afford but little elasticity and the jarring effect resulting from rough track or wheels was very noticeable in nearly all such cases. Where the stringers were widely spaced the elasticity due to long ties relieved this jarring effect very greatly and in most cases gave records nearly or quite free from instrumental vibration.

The effect of a ballasted floor on the results obtained on floor beams was even more marked than that of widely spaced stringers. The most noticeable effect of elasticity of bridge floor was freedom from jar, as shown by lessened instrumental vibration. The actual effect on impact percentage is very difficult to estimate because of the unreliable character of the records taken on the more rigid floors.

The effect of length of panel was not detected, although the deflection of the stringers undoubtedly has some influence on the cumulative vibration when the panel lengths correspond approximately with the driver circumference or the car length.

The effect of design on main girders and truss members is difficult to determine. In considering this problem it should be kept in mind that the main factor in causing impact or excess of stress in main girders and truss members is the cumulative vibration set up by the unbalanced locomotive drivers. This effect cannot be eliminated by the most perfect design for the reason that the structure is an elastic body and subject to deflection and vibration from such causes as here considered.

It is to be noted that anything which decreases the rate of vibration of a structure tends to reduce the impact by reducing the critical speed which causes maximum impact. This rate of vibration is reduced by an increase of span length, by an increase of mass and by an increase of deflection under a given load. In the case of a short span structures not affected by cumulative vibration, the same general influences prevail excepting that the rate of vibration does not directly enter since the critical speed is not reached.

Impact Under Cars and Effect of Flat Wheels.—During the progress of the special tests the subcommittee on Impact made such observations as it could relative to the effect of flat spots on car wheels on the stresses in bridges. In one series of tests a car with a wheel having a very decided flat spot was purposely used, and in other tests wheels with flat spots were occasionally noted in the test trains. In one case the tires of the locomotive were badly worn and quite rough. From these observations it is impossible to report any quantitative results. A distinct effect was noticeable on such members as stringers and floor beams. This effect was similar to that produced in the case of rough track. The effect of flat spots on main truss members of a bridge was not definitely noticed in any case.

Maximum Probable Impact as Indicated by These Tests.—In attempting to derive an expression which will represent maximum impact, it is necessary to distinguish between short-span structures, for which the maximum speed is less than the critical speed, and long-span structures; for which the critical speed is likely to occur. It seems reasonable to consider as a basis of conclusions the impact percentage plotted in plate IX. This diagram represents impact percentage for plate girders and trusses based on deflections, and also those based on flange stresses and stresses in main members of trusses

For short spans a percentage of 100 would appear to be high enough. For long spans, such that the maximum impact is dependent upon the critical speed, theoretical considerations indicate that the impact varies inversely with the span length. Following this suggestion from theory, a curve has been plotted on plate IX, represented by the formula $I=60/l$, where I=impact percentage and l=span length. This curve is shown by the dotted line. It seems to accord fairly well with the results of the tests, but it may be considered that there are perhaps too many values above this line.

It is very desirable that the law of maximum impact be expressed by a single formula. Adopting as approximately correct the two expressions above mentioned for short and long spans, namely, $I=100$ for short spans and $I=\frac{60}{l}$ for long spans, a single formula may be derived which will represent fairly well the entire span lengths. Such a formula is represented on the two diagrams by the full line. Its equation is

$$I = \frac{100}{1 \times \frac{l^2}{20000}}$$

On the whole, this single curve fits the observations quite as well, or better than the two lines representing the different

groups of span lengths. This curve is not presented here as a general impact formula, but simply as a curve which represents satisfactorily, in the judgment of the sub-committee, the maximum impact percentages obtained in this series of tests.

Summary of Results.

The following summary of results relates only to the series of tests which have been made by the sub-committee:

(1) With track in good condition the chief cause of impact was found to be the unbalanced drivers of the locomotive. Such inequalities of track as existed on the structures tested were of little influence on impact on girder flanges and main truss members of spans exceeding 60 to 75 feet in length.

(2) When the rate of rotation of the locomotive drivers corresponds to the rate of vibration of the loaded structure, cumulative vibration is caused, which is the principal factor in producing impact in long spans. The speed of the train which produces this cumulative vibration is called the "critical speed." A speed in excess of the critical speed, as well as a speed below the critical speed, will cause vibrations of less amplitude than those caused at or near the critical speed.

(3) The longer the span length the slower is the critical speed and therefore the maximum impact on long spans will occur at slower speeds than on short spans.

(4) For short spans, such that the critical speed is not reached by the moving train, the impact percentage tends to be constant so far as the effect of the counterbalance is concerned, but the effect of rough track and wheels becomes of greater importance for such spans.

(5) The impact as determined by extensometer measurements on flanges and chord members of trusses is somewhat greater than the percentages determined from measurements of deflection, but both values follow the same general law.

(6) The maximum impact on web members (excepting hip verticals) occurs under the same conditions which cause maximum impact on chord members, and the percentages of impact for the two classes of members are practically the same.

(7) The impact on stringers is about the same as on plate girder spans of the same length and the impact on floor beams and hip verticals is about the same as on plate girders of a span length equal to two panels.

(8) The maximum impact percentage as determined by these tests is closely given by the formula.

Discussion on Iron and Steel Structures.

Mr. Cartlidge: There are three changes desired by the committee. In the first paragraph of section 3 of Appendix B we desire to interpolate a sentence after the word "erection" in the second line, reading: "False work will be built by blank." In the last line in that paragraph the words "railroad company" to be replaced by a blank space. In the last paragraph in this section, interpolate in the second line between "used" and "by": "as far as practicable," so that this sentence will read, "false work placed by the railroad company under an old structure or for carrying traffic temporarily over a new opening may be used as far as practicable by the contractor during erection; provided it is not unnecessarily cut and wasted." Each one of these blank spaces is to have a dagger referring to the footnote at the bottom of the page, as follows: "Insert railroad company or contractor, as the case may be."

(The secretary then read paragraph 4.)

Mr. Loweth: I don't like the wording of the second paragraph of section 4. The contractor has to get certain authority from the engineer, according to the first line, and certain other authority from the railway company, according to the last line. I think the contractor should be obliged to take from the same person all the information and direction necessary in the conduct of this work, and I would suggest that that clause be changed to read "tracks shall not be cut nor shall trains be subject to any other delay except a reduction of speed, other than authorized by the engineer."

The President: The committee accepts that amendment.

Mr. Earle: In the first clause of section 4 it says, "and so as not to interfere with the work of other contractors." In doing work of that kind, if there are two or three contractors, it is absolutely necessary that one will interfere with the other, and as the work is done under the supervision and in accordance with the directions of the engineer, it seems to me it would be better to leave those words out.

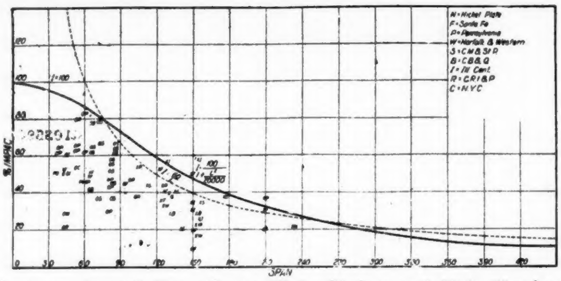
The President: The committee is not willing to accept that.

Mr. Steffens: In the last clause of No. 4 is the usual flagman provision. On some railroads there is a question of the responsibility of the flagman involved, and the specifications for contracts all read that the flagman shall be at the service of the contractor, in order to place responsibility.

Mr. Loweth: I should think that section 5 is in conflict with section 4. They may not be in conflict always, but there are methods of erecting steel bridges whereby these clauses would be in conflict. It is provided in the first clause that there shall be no work train service furnished free, except for unloading material. I know that frequently material is unloaded direct from the cars and put into structure direct, and some times it is taken from the nearest yard and unloaded, and put into its place in the work. I think the two paragraphs in the heading 5, may be in conflict in a number of methods the contractor might adopt for erecting steel bridges.

Mr. Snow: I have found it necessary in cases like Mr. Loweth has instanced, to make an estimate of what would be a fair charge for unloading. If the material is put right in place of course the contractor must expect he is going to have free service while he is erecting his bridge, and in that case you can simply make an estimate of how long it will take the train crew to unload the material in the ordinary way. I think the clause is pretty good as it stands. The word "only" helps the matter out.

Mr. Porter: In clause 5 I would like to suggest omitting the words "free of charge." Then in the next sentence I would suggest omitting the word "free." This service, under the Interstate Commerce Act, I understand, cannot be furnished unless it is a part of the contract by which the structure is furnished so that it is not necessary here to know whether it is free or whether it is to be paid for, but is simply a guide in showing what kind of service should be furnished to the contractor, which may either be paid for by the contractor or may be furnished free in accordance with the contract, so that it would read:



Maximum Impact Percentages, Plate Girders and Main Members.

"When work train or engine service is furnished the contractor, such service shall consist only in unloading materials, and in transferring the same from a convenient siding," etc.

Mr. Steffens: I would like to see the second sentence in clause 7 stricken out so that it will simply read: "The railroad company's engineers will establish lines and elevations."

The President: The committee makes the point that it is not advisable to eliminate this because they want the contractor to check the measurements and be a check on the work.

C. E. Smith: It has been my experience that unless you have that clause in the contract and a penalty attached to it, the contractor will go ahead with the work until he finds a discrepancy, and he will notify the engineer and unless you put a clause in there to make him responsible for his work he will not be so careful.

Mr. Robinson: This paragraph is intended to prevent long delays or the getting out of a lot of material on to a bridge for assembling, only to find out, after they get a couple of hundred tons of metal that something is incorrect. The engineer who has established the levels and the lines, is usually not on the ground when the superstructure is erected, and what was intended in this specification was advice to the contractor before he commences running out iron on to his false work, he should make his necessary rough checks to see whether the distance from base of rail to masonry would allow his iron to go in or whether he could get his iron in between the parapet walls or on the piers.

C. E. Smith: I would like to state a case that happened on the main line of the Iron Mountain about three years ago. They were putting in a small bridge, I think a 36-ft. span. They got the span ready to put in. The contract provided that the contractor was to check the masonry work before he put it in. He slid his span out, and tried to get it in, but could not because the steel was a little bigger than the opening. The main line was tied up about twelve hours, and I don't doubt that there are other members who could give similar experiences. There was no redress against the contractor, because the specification simply said he should "check."

A motion to refer paragraph 7 back to the committee was carried.

The President: In the second paragraph of section 9, beginning with the second sentence, the committee proposes to eliminate sentence "any changes desired to be made by the railroad company for insuring greater safety to traffic shall be made by its own forces." We also omit the word "and" and begin the sentence "no claim on the part of the contractor for delay or damage on account of such changes will be allowed."

C. E. Smith (Mo. Pac.): Paragraph 8 appears to assume that all the material will be delivered by a contractor. While this is possible in the case of one or two bridges of considerable tonnage it is not likely in the case of a large number of bridges of small tonnage, that the contractor will run up excessive demurrage charges and have his men running around from point to point. I move that there be inserted at the beginning of the third line preceding the word "materials" the following: "Where steel work is to be unloaded by the contractor the material shall be placed on skids above the ground," etc.

Mr. Steffens: This sentence as it now stands makes a contractor liable for demurrage charges, as Mr. Smith cites that the railway company is under obligations to unload. There might be a case in which the railway does not unload its own material.

Mr. Steffens: The first sentence of paragraph 10 implies the structure is going to be used again, that is, it shall be dismantled without unnecessary damage; the second sentence begins, "when the structure is to be used elsewhere." It would be well to have the first sentence begin "unless otherwise ordered" because there are a large number of old bridges coming out today that are scrapped immediately.

The President: The committee changes the words "steel work" in the first line of section 11 to "material."

Mr. McNab: Will the committee consent to remove the words "or abuse" at the end of the first sentence?

The President: The committee accepts that.

Mr. Steffens: I should like to ascertain the views of the members as to whether it is good practice to depend entirely on the bolts without pins to carry the traffic. There is nothing relative to additional rivets required beyond the usual number, plus the excess. Also, if the contractor loses a number of rivets, should not the rivets that he needs to finish the structure be furnished at his own expense? It seems to me that should be incorporated as a final clause.

Mr. Cartlidge: Mr. Steffens' suggestion as to the limit of rivets is well taken and the committee will incorporate it in a reconsideration of the specifications.

Mr. Courtenay: Referring to section 12, it frequently happens that there are a number of misfits in bridges, and it does not seem to me to be necessary to specify that the engineer shall be there or his accredited representative, always, to actually watch the rectification of the minor misfits. They are reported at the engineer's office, and he can take such steps in connection with the matter as he considers necessary. The question for debate is whether the man shall stand there and see the mechanical work done.

Mr. Cartlidge: That is the idea of the committee. The presence of the engineer during the correction of minor misfits is not necessary, but there are many cases when the engineer is necessary when misfits of a major character are being remedied, and the committee has felt that is a point which should be watched by the engineer and it is good practice to recommend that it be done.

Mr. Steffens: Is it necessary to specify that the hole shall be drilled after the metal is placed? There are certain examples I personally know of where it was a decided advantage to drill them in advance, where it was not contemplated to imbed the bolts in the masonry at that time. The holes were drilled in advance of the steel work.

Mr. Cartlidge: There is no rule without its exceptions. It is very likely that some occasions might arise in which it is preferable to drill holes in the masonry before the steel work with shoes is set, but it is undoubtedly a fact that there are a thousand cases where the contrary is the fact, and we cannot in a specification as general as this cover all the little variations which may occur in carrying them out.

C. F. Loweth (C. M. & St. P.): I hope in reconsidering this the committee will find a way in which they will permit the use of sheet lead in bed plates in paragraph 14.

Mr. Steffens: I hope the committee will see fit to cut that clause out. This matter is one that depends upon the accuracy of the engineering.

Mr. Cartlidge: The committee considered the use of sheet lead and decided against it. This question is entirely apart from the levels of the masonry, or the position of the castings. It is something which provides an accurate bearing for bed plates upon a more or less roughened surface. It is impossible to make the bed plate and bridge seat so smooth as to be an ideal bearing surface and the use of a joint between the casting and a bridge seat is good practice.

The President: The committee recommends the elimination of the words "The railroad company" in paragraph 15, putting the figure with the footnote as on the first page, and the insertion of the words "frame and" between the words "place" and "the."

The committee desires to change the word "contractor" in the first line of paragraph 16 to a blank.

The committee desires to change the second line of paragraph 18 by inserting between the words "employee," and "skilled"; the word "only."

Mr. McNab: Clause 20 says he shall assume all responsibility for injury to the workmen or the public. I think it would be better language to say "to the workmen and to the public."

The President: The committee accepts that.

Mr. Snow: Could not the last paragraph of clause 20, where it says: "he shall comply with the local and government laws," be omitted? I cannot see the necessity of saying that a man shall conform to the laws of the land.

Mr. Cartlidge: It is necessary to call attention to the fact that in the place he may be going, there may be local ordinances to which he must accommodate himself and be governed. This is a clause that would tend to keep him out of trouble.

Thomas Earle (Penna. Steel Co.): Is it the intention of the committee that the contractor shall be responsible for any injury to passengers of the railway company when, through negligence of the railway company they go through a bridge of false work which the contractor has in place?

Mr. Cartlidge: Nothing that the committee may do or say in these specifications will affect the responsibility for an accident caused by negligence. The law is clear as to where the responsibility shall be placed. The railway company is necessarily responsible to the public under the law.

Mr. Earle: We have had advice that the contractor can, if he wishes to, insure the railway company, and the execution of this specification if made a part of the contract might in certain courts be so construed that the contractor would insure the railway company.

Mr. Cartlidge: That is the intention, to make an insurance clause out of this. Clause 21 says the contractor shall carry such liability insurance as is necessary to protect himself against loss or damage caused by injuries to his men, etc.

C. E. Smith: We have been informed by our legal department that it is satisfactory for some contractors on erection to do their work without liability insurance. We have recently finished up a contract for erection with a contractor in which the contractor did not carry liability insurance. We took the matter up with the legal department and they in turn took it up with the bonding company, and the bonding company stated it was their loss if there was any. They investigate the financial standing of the erection company. If they are not satisfied that the erection company is financially sound to carry their own liability they do not issue a bond. I suggest that the committee consider that statement.

Walter Loring Webb: I want to call attention to the fact that there is a matter in clause 9 which will not stand in the courts. It is perfectly conceivable, and perhaps has happened that a railway company has made changes which they might excuse on the ground of greater safety, which would actually make increased cost to the contractor. In a case of that kind, the court would unquestionably allow the contractor damages, and there is no use in putting in a clause saying that the contractor must do that, if the court would not sustain the specification at all.

Mr. McNab: In regard to clause 22 what is the difference between the "accredited representative of the chief engineer" and the "properly accredited representative of the chief engineer?"

The President: The Committee is willing to have the word "properly" eliminated.

A motion that the specifications be referred back to the committee was carried.

Prof. Jacoby: I desire to offer the following which has a bearing on the matter of secondary stresses:

In connection with steel bridges there is hardly any material available in published form relating to the lessons taught by the observation of bridges under traffic conditions. All over the country bridge inspectors are making their rounds, looking at the details of bridges and making records of conditions discovered and recommendations as to repairs required. After the repairs are made the incident is closed for that structure, and so the matter goes on year after year. There must inevitably be some important lessons taught by the extensive experience of these inspectors which should influence design much more largely than it apparently does. One reason is that the maintenance department is entirely separate from the bridge department in which the designs of new structures are developed. There are doubtless also other influences at work. Designers and draftsmen have but little opportunity to become familiar with these matters by direct observation. It seems that each railway does not get the full benefit of the experience of the maintenance department, thus leading to the continued construction of some faulty details because the designers do not learn, except incidentally, of the actual behavior of bridges previously designed by them.

For example, certain designs of brackets on end floor beams perform their duty in an excellent manner under heavy modern live loads, and the conditions of adjacent track, while others show marked defects; yet the defective designs are built over and again on the roads in which the mantenance of way department has discovered their weakness.

This condition is not confined to steel bridges. I am convinced that some railways are losing at least two or three years of service in their Howe trusses because of the lesser relative efficiency of the splices in the lower chords. This is an indication that there are details in timber framing which are not receiving sufficient study by designers, although similar timber structures have been used for many years. This is probably true because the conditions under which failure occurs are not brought to the attention of designers.

The committee was discharged with the thanks of the association.

WEDNESDAY, MARCH 22.

The Wednesday morning session of the American Railway Engineering and Maintenance of Way Association was called to order at 9:30 o'clock, by President Fritch.

BALLAST.

The following sub-committees were appointed:

Revision of Manual: F. J. Stimson, chairman; W. J. Bergen, C. B. Brown, Jr.

Completing Physical Tests of Stone for Ballast: F. J. Bachelder, chairman; C. S. Millard, C. T. Brimson.

Proper Thickness of Ballast: H. E. Hale, chairman; J. M. Egan, S. N. Williams.

Review Report on Gravel Ballast: J. M. Meade, chairman; J. S. Lemond, C. C. Hill, G. D. Hicks.

Proper Thickness of Ballast.

Some of the reasons for the use of ballast in track construction are:

(a) To provide drainage which will lead any water that may accumulate away from the ties; or to provide a protection for the subgrade from water, as in the case of cementing gravel.

(b) To distribute the load from the ties more uniformly over the subgrade than would be done if the ties rested directly upon the subgrade.

(c) To provide a material which can readily be "worked" or tamped in all kinds of weather and which will not materially lose its carrying power or change its position as a result of the action of the elements.

The proper depth of ballast under the ties will depend, among other things, upon the following:

(a) The character of the subgrade: (1) rock, (2) firm material, as firm gravel, (3) soft material, as gumbo; (b) the kind of ballast; (c) the number and size of ties per rail length; (d) the stiffness of the rail; (e) the weight and magnitude of the wheel load and the number of applications in a given period; (f) the cost of materials used in construction of the track.

Character of Subgrade.—If the subgrade is of rock it will not be deformed by wet weather and it will carry all the load that can be put upon it by a timber tie; therefore, the depth of ballast required in this case is only sufficient to provide an equal bearing under the tie and sufficient material for tamping purposes.

If the subgrade is soft, then it is necessary to provide a depth of ballast which will produce as nearly as possible a uniform pressure on the subgrade.

Between solid rock and soft material, such as gumbo, there exists material used for subgrade of various capacity for supporting the load of the track. The softer the material used in the subgrade, the deeper should be the ballast (within certain limtis), to provide as uniform pressure on the subgrade as possible.

Kind of Ballast.—The required depth of ballast under the tie is not materially affected by the kind of ballast, although it is generally the practice to provide a less depth of stone ballast than gravel ballast. (This is probably affected by the high cost of stone.)

Number and Size of Ties per Rail Length.—The number of ties per rail length, where the roadbed is soft, materially affects the depth of ballast, for the fewer the ties the greater the weight on each tie, and a greater depth of ballast will be required to distribute the load more uniformly over the subgrade.

Stiffness of the Rail.—The stiffness of the rail materially affects the depth of ballast, for with the stiffer rail the wheel load is distributed over a greater number of ties and therefore the load on each tie is reduced. The unit weight being less, it is not necessary to distribute same as uniformly on the subgrade.

Weight and Number of Wheel Loads.—The greater the weight and number of wheel loads the greater the necessity for increased depth of ballast, so as to distribute the weight on the subgrade as uniformly as possibly.

Cost of Material Used to Construct the Track.—From an economic standpoint the proper depth of ballast frequently depends on the cost of the various materials of which the track is constructed; for example, where ballast is very expensive it may be advisable to increase the weight of rail and cut down the depth of ballast.

Dimensions of Ballast Section.—As information a statement is given showing the dimensions of the ballast sections on various railways.

Conclusion.

On account of the complicated conditions which govern the proper depth of ballast, the sub-committee feels unwilling to recommend any definite rule for the proper depth of ballast, but offer the above information as a guide to determine the proper depth of ballast where the local conditions are known.

Sub-committee B submitted no report.

Sub-committee D did considerable work upon the subject assigned to it and submitted a report to the general committee, but as the committee deemed it advisable to consider the subject of gravel ballast further before adopting the report, it was referred back for further investigation.

The committee asks that the recommendations contained in the report on the Revision of Manual be adopted.

The committee requests that the other matters assigned to it be referred back for further consideration. Some, if not all, of the members feel that there is much valuable information to be gained by further investigation of the subject of proper thickness of ballast; that independent investigations, with possibly some instrument designed for the purpose of measuring actual pressure transmitted by ballast, can be made with profit.

The report is signed by: John V. Hanna (K. C. Term.), chairman; C. A. Paquette (C. C. C. & St. L.), vice-chairman; F. J. Bachelder (B. & O.); W. J. Bergen (N. Y. C. & St. L.); C. T. Brimson (Q. O. & K. C.); C. B. Brown, Jr., (C. P.); J. M. Egan (I. C.); H. E. Hale (M. P.); G. D. Hicks (N. & St. L. R.); C. C. Hill (M. C.); J. S. Leonard (Southern); J. M. Meade (A., T. & S. F.); C. S. Millard (C. C. C. & St. L.); F. J. Stimson (G. R. & I.); S. N. Williams (Cornell College).

Discussion on Ballast.

The sub-committee on gravel ballast secured at a late hour the results of some extensive experiments, which have been made in Germany, on the proper thickness of gravel ballast, but the translation of the article which gave the results of these experiments was not obtained in time to present as part of the proceedings. We expect to use this at a later date, in connection with the work of this committee. There was a joint meeting of the committees on roadbed and ballast on Monday, at which the committees considered the question of the range of the unit pressure on top of subgrade or bottom of ballast. The sub-committee recommended that the article on "Gravel as Ballast," by C. Brauning, published in the Zeitschrift fur Bauwesen, Vol. LIV, 1904, which Mr. Dawley has translated, be published in the proceedings of the association.

Hunter McDonald (N. C. & St. L.): Referring to the report of sub-committee A, I see no reason for the insertion of the clause, "it shall be free from dirt, dust or rubbish," especially with regard to dust. Dust will certainly pass through a ¾-in. screen. I think that clause should be amended that it shall be free from foreign matter.

C. A. Morse (A., T. & S. F.): You might have rock with dust in it that would go through a ¾-in. ring, but there are roads in the country that do not make a practice of screening their ballast. I think that clause would make it the sense of the association that ballast should be screened. Regarding the size of the large ring, I would rather have it 2¾-in. than 2½. I do not think 2½-in. represents the practice at this time.

Mr. Williams: The committee made a very thorough investigation a year ago, to obtain the results of the practice from about 37 different railways throughout the country, and we found that about one-half gave the maximum as stated.

J. M. Mead (A., T. & S. F.): As one of the members of that committee, I argued against the large-size stone. It is almost impossible for the section men to surface the track or even smooth it up with 2½-in. rock, and it was my judgment that that size should not be recommended. I would favor changing it to 1½-in., or even smaller.

Mr. McDonald: Does not the manual now provide for sizes of 2½in. and ¾-in.?

The President: The manual says at present: "The maximum size of ballast shall not exceed pieces which will pass through a screen having 2-in. holes."

Mr. Mead: At the last convention the association approved the 2½-in. stone, but that action was not printed in the manual.

The President: The manual has not been reissued. This is an opportune time to make any change so that it may be incorporated in the new manual.

Mr. McDonald: I move that the wording of the clause regarding the size of the stone, as presented by the committee, be retained, with the exception that the dimension of 2-in. be restored, as it formerly appeared in the manual.

Mr. Morse: I would amend that to reduce the lowest size to ⅝ in., making it 2 in. for the maximum and ⅝ for the minimum.

Mr. McDonald: I think that one of the principal matters to be considered in the purchase of ballast is the question of commercial sizes, and if you get the size down so small as that, you will render the amount of screenings derived from it so small that there will be very little money in getting out the ballast. I prefer to retain the sizes as 2 in. and ¾ in.

Prof. Williams: The committee would like to have an expression of the members on this point.

W. H. Courtenay (L. & N.): I express the opinion that the 2½-in., as specified by the committee, should remain.

M. L. Byers (Mo. Pac.): I think you can separate the stone-ballasted track into two classes, the first being the track for passenger service. In that case you want a clean ballast, the ballast that will give you the minimum amount of dust. There is a great deal of track to which that argument does not apply with any very great force. There is much track in which you are not particularly interested in securing freedom from dust, but you are interested in maintaining the permanence of the position of your track. We have been obliged to do considerable reballasting work on a lot of track which was evidently ballasted with broken stone. I think the specification as to the upper limit probably was that the stone must go between the ties. Now, in that condition, the track is very hard to maintain, and it is hard to get any accurate surface on the track, and yet by filling that track in with smaller material and raising it sufficiently to put the coarse rock down below the bottom of the tie, we have practically formed a macadam surface, in which the ballast below the bottom of the tie has become practically a solid mass, and above the bottom of the tie, and, perhaps, for an inch below the bottom, we have a fine material, which can be cheaply worked. I think it is fairly well known that a man can put in a great many more ties per day in gravel ballast than in rock ballast, the reason being he has a finer material to work with. For track in a soft subgrade, there is no very material necessity for 2½-in. upper limit. Our experience shows that we can use 6-in. stone to very good advantage, provided there is mixed with that 6-in. stone a finer material, just the same as is used in building a macadam highway. That distributes the pressure from the tie to the subgrade to good advantage, and that is one of the principal objects of using the ballast. So I am inclined to think that in our discussion we should keep clearly in view the two requirements: first, the stone ballast for important passenger line, where it is desirable to eliminate dust, and, second, where we simply wish to have ballast for the purpose of distributing the pressure from the tie to the subgrade and consequently we want as solid a combined material as we can get.

Prof. Williams: In our investigations we found that the Pennsylvania Lines, the B. & O., and some other roads are using large sizes up to 3 in., and that the lines of great passenger traffic are favoring the larger rock, 2½ and 3 in., and so we did the best we could, and made it 2½ in., instead of 3 in.

Mr. Morse: If we could have ideal conditions, there is no question we could go from 2½ to 4 in. ballast, but it has not been found practicable to handle it. In the last lift, it is desirable to use fine ballast. As a rule, the larger the ballast used, when the road is first ballasted, the larger the subsequent ballast must be. When you get 2½-in. stone to surface on, you must make a 2½-in. or 3-in. lift every time you want to resurface.

Mr. Byers: I think that difficulty can be practically avoided by unloading the ballast in two different unloadings. It means unloading enough ballast to raise the track up to within practically an inch of the final grade, then following that with finer material, unloaded from a center dump, Rodger ballast car, and finishing the raising and ballasting of the tracks with that finer material.

C. E. Lindsay (N. Y. C. & H. R.): In specifying the maximum size of ballast you add to the cost. The stone that is larger than 2½ in. has to be re-elevated, and again passed through a crusher with additional waste, and therefore the manufacturer seeks a larger compensation. It would be interesting if the committee would decide what proportion of a given quantity of ballast should be of different sizes, varying by half inches; how much 2½-in. stone, how much 2-in., how much 1½-in., and how much 1-in. Our stone is not all 2½-in. stone, nor all ¾-in. stone. It is a mixture depending on the sizes and character of fracture of the rock. In my experience with limestone and flat rock, we do not find, with 2½-in. stone, there is any difficulty in keeping the track in first-class alignment.

C. H. Stein (C. of N. J.): I note the committee says: "Of such size that they will, in any position, pass through a 2½-in. ring." I believe it would be very hard for the rock quarries to produce such stone as would in any position pass through a 2½-in. ring. According to the fracture of the rock, a great deal of it is somewhat slabby, and, while it may have a thickness and breadth of 2 in., it may be 3 or 4 inches long, and you would find a large proportion of the ballast that would not pass through a 2½-in. ring in any position, although it would make good ballast.

Mr. Begien: It should be clearly understood that it is not necessary in the use of 2½-in. ballast to use all 2½-in. stone to raise the track. The section foreman in cleaning out would select a smaller size stone to make a ¼ or ½-in. raise.

W. J. Bergen (N. Y. C. & St. L.): It is clearly the intention of the present recommendation to eliminate those long pieces. If you specify 2½-in. ring, without saying, "in any possible direction," you are likely to get long, scaly pieces, which will powder and will not make good ballast.

Mr. Osgood: I have very strong doubts whether the 2½-in. stone, which is frequently used for ballast, ever meets this requirement without being much smaller than what we are accustomed to call 2½-in. stone. The difficulty is that in screening stone, it passes through a screen which has holes of the desired size. If you are going to enforce this specification literally, you will not have a 2½-in. stone, but nearer a 1½-inch stone.

Mr. Moss: I move that we change the lower limit to ⅝-in. diameter.

Mr. Stimson: I think it would be a mistake to lower it below ¾ in. We have found that for trap rock and granite ¾-in. is a good minimum size, but for limestone and soft stones, that break up easily, 1 in. gives the best results.

C. C. Cook (B. & O.): If the minimum size is too small, a great deal of the fine stone will pass through the fork, in cleaning, and it will be loaded with the dirt thrown down the bank. A great deal of ballast is bought by weight. We pay as much for the fine stone as for the large, and we get the use of the stone for two to five years, and it is thrown away.

Mr. Kittredge: A ⅝-in. ring would be all right for trap rock, and very hard stones, but for the majority of cases I think ¾ in. should stand. There are many limestones that are good in the ¾-in. size, which would not be in the smaller size. They would pulverize and become dusty.

Mr. McDonald: I make the point that it was disposed of last year, and we are already on record as having adopted the 2½-in. and 3-in. sizes, and I don't understand that the committee intended any change at this time in that recommendation, but simply to change the wording of the resolution, how it should appear in the manual. Now to reopen the question of size, I think, before this house, while a discussion is all right, would not be profitable, and if we wish further action we should instruct the committee to further consider it, and not reverse ourselves in this meeting.

The President: Of course the Chair must entertain any motion made by a member to change any previous action of the association. As I understand, the motion is to change the minimum size from that now adopted, to another size.

The motion to change the lower limit from ¾ in. to ⅝ in. was voted upon and was lost.

Mr. McDonald: The words "dust, dirst and rubbish" should be stricken out, and the words "foreign matter" be substituted.

After a short discussion on the wording of the report, the recommendations of the committee were adopted.

ECONOMICS OF RAILWAY LOCATION.

The following work was outlined:

(1) Consider revision of Manual.

(2) Continue the consideration of all questions connected with railway location, grades, lines, and improvement of grades and lines affecting the economic operation with relation to traffic, tonnage, ratings, speed, density of traffic and financial considerations, with the special aim in view of establishing uniform methods and unit values for investigating and analyzing the relative changes and costs of comparative routes or proposed grade reductions and line corrections.

(3) Make concise recommendations for next year's work.

Realizing that authentic data with reference to operation of railways was necessary in order to proceed much further with the work as outlined, and knowing the nature of the "walls" with

Name of Railroad.	Height and Slope of Shoulder.	Width of Roadbed.			
	Dist. from Top of Tie to Top of Shoulder.	Slope.	Cuts. *	Fills.	Tile Drains.
Baltimore & Ohio	1½ in. 1½ in. 1½ in.	c1½ to 1 1½ to 1 1½ to 1	18 ft. 16 ft. 14 ft.	20 ft. 18 ft. 16 ft.	
Boston & Maine	1 in. Bottom of tie	1½ to 1 Curved	19 ft. 5 in. 18 ft.	19 ft. 5 in. 18 ft.	
Canadian Pacific	Top tie rock Others 1 in.	Curved Curved	16 ft. 14 ft.	16 ft. 14 ft.	
Chicago & Alton	Top tie rock, bot. gr'v'l	1¼ to 1 curved	18 ft.	18 ft.	
Chicago, Burlington & Quincy	1½ in.	Rock 1½ to 1 Others 2 to 1	18 ft.	18 ft.	6 & 8 in. pipe under ditch
Chicago Great Western	Top of tie, bot. for cementing gravel	1¾ to 1 1¾ to 1 1¾ to 1	20 ft. 18 ft. 16 ft.	20 ft. 18 ft. 16 ft.	
Chicago, Milwaukee & St. Paul	1½ in. 1½ in. 1½ in.	2 to 1 2 to 1 2 to 1			
Denver & Rio Grande	About 1 in. About 1 in. About 1 in. About 1 in.	Curved Curved Curved Curved	18 ft. 18 ft. 18 ft. 18 ft.	20 ft. 20 ft. 20 ft. 20 ft.	
New York, New Haven & Hartford	Top tie rock Others 3 in.	1-1 rock 2-1-others	16 ft.	16 ft.	
Pennsylvania	Top rock and cinder 1 in. above bot. gravel	1½ to 1	14 ft. 8½ in.	21 ft. 8½ in.	6 in. C. I. pipe cross drain
Rock Island Lines	1½ in. 1½ in. 1½ in.	2 to 1 2 to 1 2 to 1	20 ft. 18 ft. 16 ft.	20 ft. 18 ft. 16 ft.	Cross drain where needed
St. Louis Southwestern	Top tie rock, bot. sand	1½ to 1	17 ft.	18 ft.	
St. Louis & San Francisco	1½ in. 1½ in. 1½ in.	2 to 1 2 to 1 2 to 1	20 ft. 18 ft. 16 ft.	20 ft. 18 ft. 16 ft.	
Texas & Pacific	1 in. from bottom, top tie rock	1½ to 1 1 to 1 rock	18 ft.	15 ft.	
Wabash	Top of tie Top of tie	Curved Curved	18 ft. 16 ft.	18 ft. 16 ft.	

Remarks.

- a Includes hard slag.
- b Incl. granulated slag.
- c Slope is being changed from c'ry'd to 1½ to 1.
- d Roadbed has transverse slope ¾ in. to 1 ft. In wet ledge cuts, depth of ballast is sometimes increased to 2 ft.
- e Includes furnace slag.
- f Cinders used in sidetracks only.
- g Includes burned clay. Ballast varies from 3 in. in sand to 18 in. in clay.
- h Includes burned gumbo. Depth of ballast varies from 6 in. to 12 in. with local conditions and variation in volume of traffic.
- k Rock used on double and 4 track. Only 4-track section shown: sub-grade had transverse slope ¼ in. to 1 ft.
- m Includes slag and disintegrated granite.
- n Includes chats. Depth of ballast varies with nature of soil.
- * Shoulder is dressed to bottom of tie in cementing gravel.
- o Includes slag and disintegrating granite.
- p Includes chats. Depth of ballast varies with nature of soil.
- * Variation from standard made account of scant supply of ballast.
- r Kind of ballast not stated. Standard not followed in sidetracks.

Name of Railroad.	Class of Track.	DEPTH OF BALLAST UNDER TIE.							
		Center of Tie—Kind of Ballast.				End of Tie—Kind of Ballast.			
		Rock.	Gravel.	Cinders.	Sand.	Rock.	Gravel.	Cinder.	Sand.
Baltimore & Ohio	A B C	a12 in. 9 in. 6 in.	b12 in. 9 in. 6 in.	12 in. 9 in. 6 in.		a12 in. 9 in. 6 in.	b12 in. 9 in. 6 in.	12 in. 9 in. 6 in.	
Boston & Maine	A Bd		12 in. 12 in.				12 in. 15 in.		
Canadian Pacific	A B	7 in.	7 in. 7 in.	7 in. 7 in.		9 in.	9 in. 9¼ in.	9 in. 9¼ in.	
Chicago & Alton		e12 in.	12 in.	f12 in.		e13½ in.	13½ in.	f12 in.	
Chicago, Burlington & Quincy		8 to 12 in.	8 to 12 in.	8g to o12 in.		8 to 12 in.	8 to 12 in.	g8 to 12 in.	
Chicago Great Western	A B C	12 in. 9 in. 6 in.	12 in. 9 in. 6 in.	12 in. 9 in. 6 in.		13 in. 10 in. 7 in.	13 in. 10 in. 7 in.	13 in. 10 in. 7 in.	
Chicago, Milwaukee & St. Paul	A B C		h12 in. h10 in. h8 in.	12 in. 10 in. 8 in.			h12 in. h10 in. h8 in.	12 in. 10 in. 8 in.	
Denver & Rio Grande	A B C D		12 in. 10 in. 8 in. 6 in.				12 in. 10 in. 8 in. 6 in.		
New York, New Haven & Hartford		9 in.	7 in.	7 in.	7 in.	k8 & 10 in.	9½ in.	9½ in.	9½ in.
Pennsylvania		6 in.	6 in.	6 in.		7 in.	7 in.	7 in.	
Rock Island Lines	A B C	m6 to 10 in. 6 to 10 in. 6 to 10 in.	6 to 10 in. 6 to 10 in. 6 to 10 in.	6 to 10 in. 6 to 10 in. 6 to 10 in.	n6 to 10 in. 6 to 10 in. 6 to 10 in.	m6 to 10 in. 6 to 10 in. 6 to 10 in.	6 to 10 in. 6 to 10 in. 6 to 10 in.	6 to 10 in. 6 to 10 in. 6 to 10 in.	n6 to 10 in. 6 to 10 in. 6 to 10 in.
St. Louis Southwestern	*	12 in.	12 in.	12 in.	12 in.	13 in.	13 in.	13 in.	13 in.
St. Louis & San Francisco	A B C	o6 to 10 in. 6 to 10 in. 6 to 10 in.	6 to 10 in. 6 to 10 in. 6 to 10 in.	6 to 10 in. 6 to 10 in. 6 to 10 in.	p6 to 10 in. 6 to 10 in. 6 to 10 in.	o6 to 10 in. 6 to 10 in. 6 to 10 in.	6 to 10 in. 6 to 10 in. 6 to 10 in.	6 to 10 in. 6 to 10 in. 6 to 10 in.	p6 to 10 in. 6 to 10 in. 6 to 10 in.
Texas & Pacific	*	8 in.	8 in.	8 in.		9 in.	9 in.	8 in.	
Wabash	A	r8 in. r12 in.				r12 in. r8 in.			

Comparison of Roadway and Ballast of Different Roads.

which the railway companies surround their statistics, the chairman of the committee wrote to the secretary on April 6, 1910, suggesting that if the directors and officers of the association, as well as such committee members as could do so, would furnish from their own roads the data required, it would give the committee substantial material to work on. The committee would hold all such information confidential, and in their reports would refer to the roads by some designating number or letter. The following information was desired: (1) A statement of the percentage to nearest one-hundredth per cent that each of the primary accounts bears to the total operating expenses, based on the Interstate Commerce Commission's classification of June, 1907. (It is desirable to have this cover a two-year period if possible.) It is particularly essential that the following accounts be subdivided, if possible, in order to make a proper analysis: "Other track material;" "railway and track;" "bridges, trestles and culverts;" "buildings, fixtures and grounds;" and where possible it is particularly desirable that the following be divided between passenger and freight service: "Station employees;" "road enginemen;" "fuel for road locomotives;" "road trainmen;" "train supplies and expenses." (2) Operating expense per freight train mile. Operating expense per passenger train mile. (3) Trains per annum per mile of road; freight; passenger. (4) Approximate average running speed; freight; passenger. (5) Approximate tons train, including equipment; freight; passenger. (6) Number cars per train; freight; passenger. (7) Number pounds coal per train mile; freight; passenger. If fuel oil is used, the quantity per train mile for each class service should be given. The (2) to (7) data should be given for each class of track covered by reports received under clause (1). The committee also needs further information with reference to relative wear of rail on curves, compared to wear on tangent under same traffic conditions. This is essential as one of the elements entering into the value of curvature.

On September 19, 1910, the president sent a letter to each member of the board of direction, requesting that they furnish the desired information. Four replies have been received to the president's letter up to December 13, 1910. Other members of the board may be compiling the information requested. It is certain that nothing of real value can be done by this committee if they are not furnished with sufficient information on which to base conclusions. The work of this committee is vitally connected with the economic operation of railways, and its work must cease if the railways represented in this association cannot furnish the required statistics. Neither can the railways expect members of this committee to devote hundred's of dollar's worth of time to the work if the roads take the position that they do not care to assume the expense of gathering the information. The chairman and some of the members are making such investigation as they may have time for, along the lines of the committee's work, but these are individual studies which cannot extend beyond the narrow field of statistics immediately available. The chairman recommends that the committee be discharged from further study of the question, unless the board considers the work of sufficient importance to furnish such information as may be required from time to time.

The report is signed by A. A. Shurtleff, chairman.

R. N. Begien: I am sorry Mr. Shurtleff is not here to make a statement to the convention with regard to the failure of the various railways to furnish data for the committee to work on. Up to the present time I believe answers have been received from about seven railways, those being the ones represented by the members of the board of direction. The sub-committee, which had in charge the subject of tonnage rating with respect to economical operation, has conducted certain tests on the Baltimore & Ohio this year to determine train resistance. In order to make those tests final, and as conclusive as possible, engineering corps were organized to run the profiles of the various divisions, which were to be examined. We made, first, tests of passenger trains. There were fourteen runs aggregating 4,000 miles. Then there were 12 runs made of fast freights, with an idea of examining particularly speeds between 20 and 50 miles an hour of freight trains, and after that, about 6,000 miles of slow freight runs were made. We were able to examine the resistance on two divisions only, owing to the time between the finishing of the runs and the time of this convention. On these runs we took observations for coal consumption, water, steam, the train line, position of the reverse bar, and the throttle, and in examining the water consumption, the calibration of the tank was made and the number of minutes that the injector was in service was noted. We have all of the material for making a very complete report, but it will take considerable time to do it. A year ago the committee reported that on slow freight work but little change of resistance was noted between 5 and 35 miles per hour. After examining the work on our Newark division, between those same speeds, I believe that we are justified in still making that contention. There have been some experiments made during the year which would not seem to bear out that contention, but I believe that on mixed trains containing cars of various weights, it can be safely said that for all practical purposes, there is little change in resistance between 5 and 35 miles per hour. Another point of interest was noted in connection with temperatures. One train was taken out of our yard at Newark, Ohio, which had been standing all night. It took two engines to get it out of the yards, although the grade was slightly below the ruling grade. For nearly two hours after the train had started it was noticed that the resistance was high. On leaving the yard the train resistance was about 20 pounds to the ton, and stayed up to that point for half an hour, and it was not until the train went over the summit nearly two hours later, that the normal resistance began to be noted, which averaged very close to what was established in the formula adopted by this convention last year. In fact, I might say that up to date the net results of the experiments have been that the formula published in the proceedings last year appears to be a fairly good formula for practical use.

The President: The board of direction has given careful thought and attention to this committee, and there is one recommendation which the chairman of the committee made, which the board of direction and the association is not ready to adopt, and that is that this committee be discharged from further study of the question. The members of the board of direction, at least, expect to make every possible effort to furnish information to this committee. Mr. Shurtleff has given a lot of his valuable time, energy and skill to this work, and we are not ready to accept his resignation. I think the association should give this committee all the assistance and support possible in the way of information, because without information this committee cannot carry on its work.

Mr. Kittredge: I want to say possibly in justification of those who have not given the committee the data they desire, that there is really very litle information available in actual figures and tests. We all know and appreciate the advantages derived from economic location and changing grades, but very few of us have any figures that we can put into print, showing the actual economics that have been accomplished by changing grades. I appreciate the position of the committee, and yet I do not think it is putting the roads that have not furnished the information quite in the proper light to leave the impression that they have been negligent. We have not been negligent; we have been unable to give it in the way it is wanted.

Mr. Thompson (B. & O.): The results of the dynamometer tests which Mr. Begien has mentioned, will be platted up, and the full results and report will be gotten up by the B. & O. and given to the committee. With due respect to the remarks of Mr. Kittredge, I think some of the roads have not felt the importance of the committee's work, and they probably thought that they did not have any data on this subject. I believe that if each railway would at least recognize the committee's letters, the committee would go farther than they have gone in making an intelligent report. To show the value of one point that Mr. Begien makes, of the resistance of trains out of yards, we are spending on two new yards that we are completing, an additional amount of about $60,000 to reduce the grade out of the yards to give the trains a chance to get out promptly. That point demonstrates how slowly trains move out of the departure yards.

TIES.

Sub-committees were appointed as follows:
Revision of the Manual: E. E. Hart, chairman; W. F. Finke, G. W. Merrell.
Statistics: L. A. Downs, chairman; F. G. Jonah, Edward Lass.
Metal, Composite and Concrete Ties: W. F. H. Finke, chairman; H. S. Wilgus, E. D. Jackson, F. R. Layng.
Use of Cypress as Tie Timber: F. G. Jonah, chairman; A. F. Dorley, H. C. Landon.

The sub-committee on revision of the Manual has no recommendation to make for changes in the present version.

Under Appendix A will be found the report of the sub-committee on cross-tie statistics.

Supplementing its previous reports on the subject of metal, composite and concrete ties, this sub-committee presented a progress report. A circular letter was sent to the roads using the various metal and composite ties, and their replies indicate that there has been little change in the condition of these ties from what they reported last year, and that these ties are still generally giving satisfactory service. No new type of practical design has been patented or installed.

As opportunity has offered, the sub-committee has examined ties removed from track by sectionmen in the regular work of renewals, and measurements to determine depth of cut were made by means of a straight edge and a wedge-shaped graduated gage. It was found that where the ties are not protected by tie-plates the cutting or abrasion of the ties by the rails and the outward tilting of the rails is marked on tangents as well as curves, and adzing of the ties at intervals is necessary on both curves and tangents to maintain the rails in position perpendicular to the plane of the tie. The measurements taken show the maximum cutting of the ties, as all ties examined had been removed from track. From observations and from information obtained, the sub-committee is of the opinion that flanged tie-plates of suitable width and thickness and properly applied, on tangents as well as on curved track, will lengthen the life of cross-ties from one to two and in some cases three years, and in the meantime the track will have been maintained in better gage, line and surface, and at less cost, than the same track could have been without tie-plates.

Conclusion.

The committee presents this report as a report of progress. The report is signed by: E. E. Hart (N. Y. C. & St. L.), chairman; W. F. H. Finke (Southern Ry.), vice-chairman; A. F. Dorley (M. P.); L. A. Downs (I. C.); W. F. Goltra, Cleveland, Ohio; E. D. Jackson (B. & O.); F. G. Jonah (St. L. & S. F.); H. C. Landon (Erie); Edward Laas, Los Angeles, Cal.; F. R. Layng (B. & L. E.); G. W. Merrell (N. & W.); L. M. Perkins (N. P.); H. S. Wilgus (P. S. & N.).

Appendix A.

Statistics of Cross-Ties.

The sub-committee issued the following circular of inquiry:

"In endeavoring to collect data relative to statistics of cross-ties, the Committee on Ties has concluded that few railroad companies, if any, have complete or reliable information concerning the life of ties. Most railroad companies have good records of renewals of cross-ties each year, and, in many cases, keep such records by miles.

"It is believed that the approximate life of ties can be arrived at in the case of new track, built within the last ten or fifteen years, the number of ties originally placed in the track being known and also the total number in the whole length of track and the number taken out of track each year.

"During the past ten years you have probably built extensions of some kind, or built new second track, or had grade reduction work where certain kinds of ties, either treated or untreated, have been put in out of face. It is immaterial if the track is one mile or 200 miles in length. Information of this character is what the committee desires.

"Enclosed herewith is a blank form which can easily be filled out showing the year the ties were laid, the number removed each year to date and the kind of tie used, whether treated or untreated.

"Date constructed; between what two cities or towns; state; length of track in miles; number of ties per mile; total number of ties; kind of ties; number of ties used in renewals, according to years, as follows: 1895, 1896, 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1904, 1905, 1906, 1907, 1908, 1909, 1910."

The replies received in answer to this circular have been tabulated and are given in Table 1.

Appendix C.
The Use of Cypress as Tie Timber.

The increasing use of cypress as a tie timber has led the committee to make some investigations concerning same, and accordingly a postcard inquiry was sent out to proper officers of all the roads operating in the South Atlantic and Gulf States, where cypress ties are most generally use. The following questions were asked: Number of cypress ties in track; dimensions; kind of cypress; red, white, yellow; pecky, clear; average life; remarks.

Replies were received from a great many roads giving the information wanted. Several roads replied that they had many cypress ties in track, but had no accurate record, and consequently gave no figures, while a number made no reply. The information obtained is tabulated and published in the appended table.

Discussion on Ties.

Mr. Wendt: I promised the committee to give them some data on the cost of labor in connection with the two experimental sections of track on the Pittsburgh & Lake Erie. This track was originally laid in 1907 and was not resurfaced for fifteen months. In the fall of 1908 both sections were resurfaced, the cost of labor being the cost of track labor.

Three thousand steel cross ties, Carnegie design, with clip and bolt rail fastenings, were placed in northward freight track, McKees Rocks, Pa., in September, 1907, by the Pittsburgh & Lake Erie. These steel ties are laid in a stretch of track 4,400 ft. long. The succeeding 4,400 lineal ft. of the same northward freight track was laid at the same time with new No. 1 white oak ties. New steel rails, 90 lbs. A. S. C. E. section, were laid on these ties, and new limestone ballast was used throughout the entire length of 8,800 ft. of track. The track was originally surfaced in September, 1907, the depth of ballast being about 8 in. Since that time a careful record of all labor expenses in connection with the maintenance of both steel and wooden tie sections of experimental track has been kept. After being originally built and ballasted, these two sections of track were not surfaced a second time for a period of about fifteen months. In November, 1908, both sections were resurfaced, the cost of labor being: Cost of track labor per mile per year where wooden ties are used, $417; cost of track labor per mile per year where steel ties are used, $280. During the following 12 months these two pieces of track were simply patrolled, no labor being expended on either line or surface. In November, 1909, both stretches of track were resurfaced with the following result: Cost of track labor per mile per year where wooden ties are used, $95; cost of track labor per mile per year where steel ties are used, $153. During the succeeding 12 months the track with steel cross ties was resurfaced three times, while the track with wooden ties was resurfaced once, with the following result:

DATA RELATING TO CYPRESS TIES.

Name of Road	Official Reporting	No. of Ties in Track	Dimensions	Kind of Cypress	Clear or Pecky	Average Life in Track	Remarks
Central of Georgia	C. A. Lawrence, Chief Engr.	1,334,739	7x8x9	Red and black		No accurate date; 10 to 12 years when protected with tie plate.	The number given is the number of red and black cypress ties that have been put in track since 1900, averaging 133,474 per year.
Charlotte & Western Carolina R. R.	A. H. Porter, Engr. R'dway.	440,000	7x9x8½	Red and black		12 to 14 years	White and yellow cypress not used in this section. Will not last more than 2 or 3 years. Tie plates required where traffic is heavy and on curves.
Chicago, Rock Island & Pacific	J. B. Berry, Chief Engr.	None					Think of trying some pecky cypress in Louisiana.
Cleveland, Cincinnati, Chicago & St. Louis R. R.	C. S. Millard, Engr. Track & Roadway	2,200					1,000 on Cairo Division, 1,200 on Vincennes Division in Illinois, been in about 7 years, are in fair condition.
Florida Central Ry	J. H. Davidson, Gen. Supt.	None					We will use red and black cypress after this year.
Florida Railway	W. A. Swallow, Ch. Engr.	10,000		Red	Clear		O. K. with tie plates.
Georgia & Florida	Superintendent,	20,000		Red and white			Practically all ties new within last 2 years.
Georgia Coast & Piedmont	T. S. Williams, Roadmaster	50,000	6x8 to 7x10	Red and white All classes			
Georgia Railroad	W. M. Robinson, Roadmaster	30,000	7x8x9	Red, black and yellow	Pecky		Have been in use about 4 years. As cross-tie timber white cypress is of little value.
Illinois Central	A. S. Baldwin, Chief Engr.	2,000,000	6x8x8 7x9x9	Red, black and yellow	Some pecky mostly clear		We find the average of white or yellow cypress ties, if ¾ sap, 2 to 3 years; if all heart, 8 to 12 years; red, 12 to 15 years.
International & Great Northern	O. H. Crittenden, Chief Engr.	200,000	6x8x8	Red and yellow	20% pecky 80% clear	12 years	More than ¾ wear out, life of other ¼ about 12 years.
Louisiana Railway & Navigation Co.	C. R. Mee, Roadmaster	95% of 333 miles	6x8x8 7x9x9	Red		Red, 11 years; yellow and white heart, 8 years.	Cypress is the tie for this climate.
Louisville & Nashville	W. H. Courtenay, Chief Engr.	1,397,915	7x9x9	Red, white and yellow			All laid on divisions south of Montgomery.
Missouri Pacific Railway	M. L. Byers, Chief Engr. M. of W.	100,000	6x8x8	Red and white	Both		Would not recommend using cypress ties unless I could get all heart.
Mobile & Ohio	B. A. Wood, Chief Engr. of Maint.	10,000	7x9x8.5	Red and white	Both		Red and yellow cypress ties are the best, from 2 to 4 years longer than white oak under similar conditions.
Norfolk & Western	C. S. Churchill, Chief Engr.						Up to 1890 this road used large numbers of cypress ties, secured along its line in eastern part of Virginia. We found their life to be from 12 to 14 years. The demand for cypress for shingles, etc., became so great, no longer put on market for cross-ties. We ceased buying cypress for ties in early nineties. Last few years have been using red cypress ties in track in tunnels.
St. Louis & San Francisco	M. C. Byers, Chief Engr. Operation	175,000	6x7x8 6x8x8 6x8x9 7x10x8			10 to 15 years for red and yellow	50,000 red cypress treated ties in Oklahoma, 115,000 red cypress untreated ties S. E. Mo. and N. E. Arkansas. Will outlast oak. White cypress not good. Pecky cypress will last long time but will not hold spikes.

Cost of track labor per mile per year where wooden ties are used, $128; cost of track labor per mile per year where steel ties are used, $428. These experimental sections being part of the northward freight track in the four-track system, electric circuits in connection with automatic signals are in use, and it is interesting to know that during the 42 months in which these steel ties have been in use the fiber insulations have given no special signal trouble. The track at the present time is in good line and surface, and while all bolts and clip fastenings on the steel ties are tight, it is a fact that the fiber insulations are considerably worn, and this condition permits the rail to creep in the direction of traffic, which results in the ties being slued. The drainage of this track is good. During 1909, 20 broken angle bars were removed from steel tie joints. During 1910, 18 broken angle bars were removed from steel tie joints. The speed of freight trains at McKees Rocks, where this track is located, averages about 30 miles per hour.

These figures simply represent the annual results in connection with an experiment which has now been in progress three and one-half years. The data is interesting but is not conclusive, for the reason that the relation of the expense in connection with a wooden tie track and a steel tie track varies. In the early days of the experiment, one character of track could be maintained with a less amount of labor, while in the latter experiment the situation was changed. It is not apparent at this time just what the results will be at the end of the fifth, seventh or tenth year

RAIL.

The work outlined was as follows:

(1) Consider revision of Manual.

(2) Continue the investigation of the breakage and failure of rails and present summary of conclusions drawn from reports received.

(3) Report on the results obtained from the use of open-hearth and special alloy steel rails, and chemical composition of such rails.

(4) Present reports on the results of tests made in conjunction with the Manufacturers' Committee on the various kinds of rail, made by means of the special machines at the Pennsylvania Steel Company's mill and the Sparrows Point mill of the Maryland Steel Company.

(5) Report on any recommended changes in specifications for steel rails.

(6) Present recommendations on standard rail sections.

(7) Present report on rail joints, showing results of all tests at Watertown Arsenal, and recommend design and specifications.

(8) Reconsider and report any recommended change in standard drilling for rails, as given in the Manual.

(9) Make concise recommendations for next year's work.

Revision of Manual.

It is believed by the committee that the subject matter on Temperature Expansion for Laying Rails, 1907 edition, page 53, belongs to committee V, Track, and recommends that it be transferred to the chapter containing the recommendations of that committee.

In view of subsequent changes adopted, it is recommended that the Form of Reporting Rail Failures in Main Track, M. W. 1200, in the supplement to the Manual, bulletin No. 103, pp. 16 and 17, be withdrawn and replaced by Form M. W. 404, Report of Rail Failures in Main Tracks.

The revision of this form was undertaken on account of the suggestion of C. E. Lindsay at the annual convention in March, 1910, that there ought to be a method for indicating the "Gage Side" of the rail, and this deficiency has been supplied by the addition to Question No. 39. At the same time, the numbering of questions was changed to eliminate the letters, and some of the questions were arranged in what was thought to be a somewhat better order.

Statistics on Rail Failures.

While statistics of rail failures for the six months' period ending October 31, 1909, were published in bulletin No. 121 last year, data from a number of the roads was not received in time to be included. Therefore, the previous work in this bulletin has been included with the data since received in appendix B of this report.

This information is the most complete on the subject ever published. It has been stated by some that they do not believe these statistics furnish any information of value, but the committee believes that a careful study of the information will not warrant this conclusion. There are many hints to be derived from their

DATA RELATING TO CYPRESS TIES—Continued.

Name of Road	Official Reporting	No. of Ties in Track	Dimensions	Kind of Cypress	Clear or Pecky	Average Life in Track	Remarks
St. Louis, Brownsville & Mexico.....	E. C. Burgess, Engr. M. of W.	207,775		Red, white and yellow	Both		
Seaboard Air Line..................	J. C. Nelson, Engr. Maintenance of Way	2,000,000	7x9x9	Red and black	Both		If you are gathering data to get up specifications, I would suggest that you omit the names of different kinds of cypress and simply specify heart cypress. My experience has been that the names are simply local, and that what is known as yellow and red, etc., in one state, may be entirely different in another, but the heart of any cypress in any state, no matter what its local name may be, is all right. On the other hand, cypress known as red, black or yellow is worthless, unless it has heart. We get cypress in North Carolina, South Carolina, Georgia, Florida, Alabama and some little in Eastern Virginia. Timbermen in some of these sections will tell you that yellow cypress is all right, and another will say that it is worthless, and after some years' experimenting and groping in the dark, I found that the name cuts no figure, and while along the line of our road we use the names red and black, it really means nothing and we are very careful to specify the heart dimensions.
Sunset Lines, Atlantic System........	A. V. Kellogg, Engr. M. of W.	5,705,567	6x8x8 7x8x8 7x9x8 7x9x9 8x10x10	White	Clear		
Tampa & Jacksonville.............	F. C. Parrigin, Engineer	7,000	7x9x8.5	White	Clear		These ties have been put in, in last 24 months. Indications are they will last about 4 years.
Texas & Pacific Ry................	B. S. Wathen, Chief Engr.	2,633,664	7x9x9 6x8x8	Yellow, red and black	Clear		We have not had any cross-ties of this class in use longer than 7 years; believe 10 years about the average life.
Vicksburg, Shreveport & Pacific..... New Orleans & Northeastern.......	E. Ford, Asst. to Prest.	175 miles 46,000	7x9x9 7x9x9	Red and yellow Red and yellow	Both	12 years	V. S. & P. Delta Point to Shreveport; 175 miles laid with cypress ties, 2,816 to the mile, only receive red or yellow cypress. Do not object to pecky ties if they are not so pecky as to prevent holding spikes; yellow cypress ties do not last as long as red cypress ties but last considerably longer than pine or oak ties. V. S. & P. has no curvature exceeding one degree; have but little trouble with cypress ties on curves. The cross-ties on the N. O. & N. E. would get too soft and have to be taken out from mechanical wear instead of from decay. Cypress ties on N. O. & N. E. are of poor quality and will not last as long as ordinary pine ties.

Total No. of Ties in Track, 17,780,076.

study, and one of special importance is that differences in the production of ingots and the finished rail made from them may annihilate all advantages derived from any particular rail section. The design of rail section is not, therefore, the main cure for poor material.

Experiments and Tests.

M. H. Wickhorst, the engineer of tests for the committee, has been conducting experiments and tests under the direction of the committee for the past year, and the results of his work are issued as appendix E of this report. In connection with the eleven separate reports made by Mr. Wickhorst, a statement of the results believed to have been accomplished by this work up to the present time is furnished.

Specifications.

Of course, the principal work of this committee is the preparation of a standard set of specifications for steel rail, and the large amount of data and statistics being published in these reports from time to time by the committee are to enable the members of the association, as well as the members of the committee, to determine upon a set of specifications which will bring about the manufacture of "good steel rails." The subject is a very intricate one and its study carries one back through all the processes of manufacture. It will, therefore, be readily seen that a large amount of time is required for this study, involving, as it does, the making of tests and the carrying on of experiments.

It is believed by the committee that no rails have as yet been purchased under the tentative specifications, but the differences between them and the specifications used by some of the large railroad systems are not very great. They are being brought nearer together all the time.

Rail Sections.

No attempt has as yet been made by the committee to design a new rail section, as many of the large systems have begun to use the two types, A and B, designed by the American Railway Association, and it has been thought advisable to obtain information derived from service, relative to these sections and others of special design which may be in use, before making any new recommendations. These new designs are being watched, and it is hoped that in the course of time some definite information will be obtained. At present there are two parties, one favoring type A, representative of the high stiff design with thin head, and the other type B, representative of the lower and more flexible design, with heavy head.

In order to throw some light on the controversy between those representing the thin head, on the one hand, and the heavy head, on the other, Mr. Wickhorst made his study on the "Strength of Rail Head," in his report No. 9 of appendix E. This study was intended also to give some information relative to the claim that the head of a rail is broken down by the excessive equipment loads of the present day, even though there be no physical defect in the interior of the rail head.

Tests of Rail Joints.

The first series of these tests, made at the Watertown Arsenal, were published in bulletin No. 123, as appendix A, and are to be regarded only as a progress report, as the entire series of tests have not been completed. Very guarded use should be made of the information in these tests, as the material in the different splice bars varies so widely that it is difficult to judge of the value of the different designs. The state of affairs is the same as in the case of the rail section, when the committee pointed out that all differences in rail section can be annihilated by the quality of the material.

Standard Drilling for Rails.

This study has been commenced, but has not yet proceeded far. Only progress, therefore, is reported.

Miscellaneous.

Mr. Churchill has made a valuable study, involving the compilation of a large number of tests, which is included with this report as appendix C, Statement of Drop Tests and Chemical Analyses of Rails Rolled for the Norfolk & Western, giving results of various heights of drop on rails of known composition, and a comparison of rail analyses with mill analyses.

A tabulated statement of the different practices in connection with rail rolling in American mills has been compiled and is submitted herewith for the information of the members.

Recommendations for Work in 1911.

As nearly all of the different items of work of the mill committee are leading up to the preparation of a standard set of specifications for steel rail and the design of a standard rail section, together with the appliances that go with the rail, and as these specifications and designs have not yet been completed, it is recommended that the outline for the committee's work during the coming year be the same as that for the past year.

Under item No. 4 the committee desires to make a closer study of ingot making, as the principal defects connected with rail manufacture seem to have their origin in the making of the ingot. It is true that the temperature of the bar during manufacture and the amount of work done upon it have strong effect on the subsequent quality of the finished rail, but the studies of your committee lead it at present back to the ingot as the source of our most serious defects, viz: brittleness, unsoundness and segregation.

The committee also hopes to study the relationship of the chemistry to the deflection under the drop, for the purpose of making a deflection formula, and in this connection it may endeavor to establish a relationship between the tensile strength and the elongation, or between the permanent set, as given by the drop test, and the elongation, so that the ductility of the metal shall be valued in the acceptance or rejection of the material, by means of a coefficient, as has already been done by Professors Tetmajer and Dormus. Work in this line has already been done for the New York Central Lines by Dr. P. H. Dudley, and his own statement of his practice is submitted as appendix F.

Conclusions.

The committee presents the following conclusions:

1. That the subject matter on Temperature Expansion for Laying Rails, Manual, 1907 edition, page 55, be transferred to the chapter in the Manual containing the approved resolutions of committe V, on Track.

2. That the Form of Reporting Rail Failures in Main Tracks, M. W. 1200, be replaced in the Manual by Form M. W. 404, Report of Rail Failures in Main Tracks.

3. That the changes in Form M. W. 405 (old No. 2002-B) be approved, and the form included in the Manual.

4. That the drawing Showing Standard Locations of Borings for Chemical Analyses and of Tensile Test Pieces be adopted and included in the Manual.

5. That the form for tabulating Results of Drop Tests and Surface Inspection of Rails be adopted and included in the Manual.

The report is signed by: Charles S. Churchill (N. & W.), chairman; R. Montfort (L. & N.), vice-chairman; Robert Trimble (Penna. Lines), E. B. Ashby (L. V.); J. A. Atwood (P. & L. E.); A. S. Baldwin (I. C.); J. B. Berry (C., R. I. & P.); M. L. Byers (M. P.); W. C. Cushing (Penna. Lines); F. A. Delano (Wabash); Dr. P. H. Dudley (N. Y. C.); C. H. Ewing (Atlantic City R. R.); John D. Isaacs (Harriman Lines); Thomas H. Johnson (Penna. Lines); Howard G. Kelley (G. T.); J. W. Kendrick (A., T. & S. F.); George W. Kittredge (N. Y. C.); D. W. Lum (Southern); Joseph T. Richards (Penna. R. R.); J. P. Snow (B. & M.); A. W. Thompson (B. & O.); M. H. Wickhorst, engineer of tests, rail committee.

Appendix B.

Rail Failure Statistics for Six Months' Period Ending October 31, 1909.

Statistics for this period were first published in bulletin No. 121, but, owing to the desire to have the report ready for the annual convention in March, 1910, the reports for a number of railways which were late in coming, were omitted. After the convention it was decided by the rail committee that it would be advisable to re-tabulate the information, using all the reports which had been received in answer to A. R. A. circular No. 966. The statistics are for the greater number of the large railway systems, and the number of tons reported is 7,445,825.

In considering the number of failures, all lots less than 1,000 tons have been ignored, as they usually lead to exaggerated results. It should be borne in mind that these records are for six months only and in some cases the failures have not begun, while in others the poor rails have been pretty fairly weeded out.

Taking all the reports, the failures are divided into broken, head failures, web failures and base failures, according to the following percentages: Broken, 19 per cent; head, 66½ per cent; web, 8½ per cent; base, 6 per cent.

The above are divided for the different weights of rail and between Bessemer and open-hearth steel.

These figures do not show that the breakages of the heavy sections are fewer than the lighter sections, except in the case of 75-lb. rail. The head failures, however, of the 100-lb. rail seem to be materially less than those of 90-lb. and 85-lb. rail. With the Bessemer steel the head failures are the most numerous, those for the 90-lb. being slightly more numerous than for the others. Those for 85-lb. and 100-lb. rails come next, and are nearly the same. The number of breakages is closely the same in all cases, while the web and base failures are quite insignificant. With the open-hearth steel the head failures of the 80-lb. rail are the most noted. In drawing comparisons between different sections of Bessemer rail, the head failures of P. S. 85-lb. rail are the most noticeable, amounting to 35.8 per 10,000 tons laid, but the explanation given is that they are principally from a lot of 2,045 tons on the Northwest system of the Pennsylvania Lines West of Pittsburg of Carnegie 1909 rails. During the month these rails were rolled many defective heats were found, indicating that the failures were caused by the quality of the material and not the rail section. Broken rails are comparatively few, the most noticeable being the C. S. 75-lb. and then the P. R. R. 100-lb.

In comparing the sections of open-hearth rail, the head failures are the most numerous in the A. S. C. E. 90-lb., G. N. 85-lb., C. S. 90-lb., and A. R. A.-B. 90-lb. There is considerable difference between the A. R. A.-A. and the A. R. A.-B. 90-lb., but it will be found that the greater number of failures come from Bethlehem, which simply happens to be in this case the A. R. A.-B. section. The failures of the same section of rails from the Gary mills are much less in number. This last statement gives the clue to the real cause of the failures and further studying into these statistics will bring out this fact more strongly, viz: that the cause of failures is in the quality of the material and not the design of the rail section.

In making a comparison of failures for different lengths of time, it is pretty generally known that most of the failures of any lot of rails occur during the first four years.

The marking of the rails to distinguish the position in the ingot has become very general, but, of course, the position of most of them is still unknown. In general, the failures of "A" rails are the most numerous, but it is noteworthy that there are many failures down to "D" and "E" and occasional ones in "F." In some cases they are very numerous in "D" rails.

Thoughts Resulting from the Study.

(1) The study of these general statistics does not furnish accurate and specific information so as to determine the value of different sections of rail because:

The conditions of traffic are different. The conditions of roadbed are different. The conditions of ingot making and rolling practice are so different that the quality of the material varies widely, and this difference in the quality of material eliminates differences in section.

(2) The study of these general statistics tends to disclose unusual results.

(3) The general statistics are also important in showing the relation between broken rails and failure of roadbed, web and base.

(4) The tabulation of the statistics discloses the differences between steel companies when the sections and chemical composition are practically the same.

Appendix C.

Drop Test of Rails.

This report gives statement and tables of drop tests and chemical analyses of open-hearth rails rolled for the N. & W. Railway, giving results for heights of 15 ft., 18 ft. and 20 ft., and a comparison of the mill analysis with analysis of the borings from the rail. They were all 85-lb. rails of the A. S. C. E. section, except some 100-lb. A. R. A. section, type B made at Gary.

The tests were arranged for by C. S. Churchill, and made by J. A. Colby, inspector, at the various mills, through the aid of the manufacturers; and the chemical check analyses and reports thereon were made at the laboratory of the N. & W. Railway by J. H. Gibboney, chemist of the N. & W. Railway. The tests were made on a few melts of a regular rolling.

One piece for drop test was cut from extreme crop end of an

"A" rail of each melt and subjected to test in a standard machine to a drop of 15 ft., and a very short section from this same piece was sent to Roanoke, Va., for analysis. In same manner two more pieces from other "A" rails of same melt were subjected to drop tests of 18 ft. and 20 ft.

The tup was 2,000 lbs., the anvil 20,000 lbs., spring supported and supports 3 ft. apart. The sets, also elongation of base and contraction of head under these tests, were noted over six 1-in. spaces.

From the first "A" rail, also from a lower rail from an ingot, taken at random from same melt, very short pieces were cut out for chemical analysis to furnish a comparison between the mill analysis and that of the rails, and the position of these chemical test pieces is noted in the statements.

Carbon and Deflection of Rails in Drop Test.

This report covers a study of the influence of carbon on the deflection of a rail in the drop test and is based on the results of the drop tests given by C. S. Churchill. For this study the permanent deflection at 15 ft. was used and the analysis by Mr. Gibboney was used of the sample representing the outer part of the section of the rail, as the outer fibers have more influence on the deflection than the interior ones. Only those results were used where the outer and the interior samples show about the same composition.

The element having the most influence on the deflection is, of course, the carbon, and, judging from our knowledge of the influence of the elements on the tensile properties, it is probable that phosphorus exerts an influence and perhaps manganese does, also. Sulphur need not be considered, and probably silicon has only a minor influence, if any, in the quantities that exist in rail steel. At any rate, it cannot be considered in a preliminary investigation. In order to show up concisely what relationships may exist between carbon and deflection in the various lots of rail tested, I have plotted, in Fig. 1, the carbon-deflection diagrams for the Carnegie, Tennessee and Bethlehem rails, showing the per cent of carbon horizontally and vertically the permanent deflection of the base side of the rail under a 15-ft. drop.

In drawing the deflection curves, the "average" points or "centers of gravity" were given a weight according to the number of single points they represent. A few points that fell entirely out of their "zone" were ignored in drawing the curves. The curves are represented as straight lines and no attempt at closer fitting has been made, as with the small amount of data in hand and their small range, there must be considerable doubt as to even the slope of the line, let alone its curvature.

Of course the deflection lines discussed above represent the combined effect of all the stiffening elements, although the slope would be due to carbon, providing the other stiffening elements were constant. It may be said that in general the phosphorus variations have had no influence on the slope of the carbon-deflection lines shown in Fig. 1. It seems probable that in the Carnegie and Tennessee rails that manganese has had no material influence on the slope of carbon-deflection curve.

It will be noted that within a carbon range from about .60 per cent. to about .75 per cent the stiffening effect in these tests of a change .01 per cent carbon was about .009 in. for the Carnegie rails, about .026 in. for the Tennessee rails, and about .021 in. for the Bethlehem rails, all being 85-lb. rails of A. S. C. E. section, with a nominal moment of inertia of 30.0.

Very roughly, then this investigation indicates that above .60 per cent each .01 per cent carbon increase causes a decrease of deflection of base side of about .02 in. on 85-lb. O. H. rails of A. S. C. E. section when tested in the standard rail drop machine with tup of 2,000 lbs., span 3 ft. and height of drop of 15 ft.

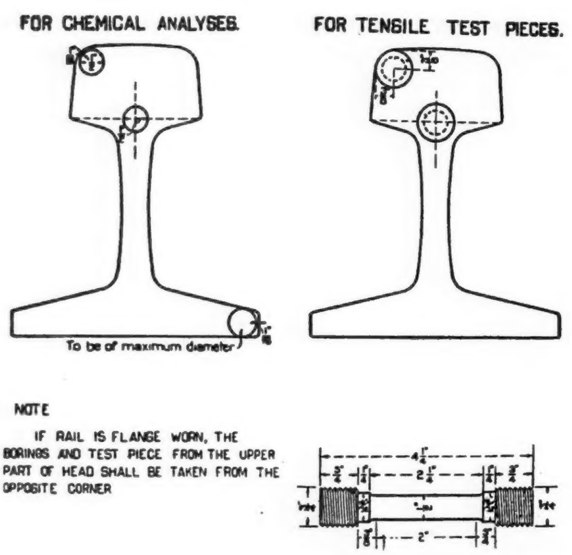
The above study gives us some idea of the quantitative effect of carbon on the deflection of a rail in the drop test, but offers no information as to the effect of other elements. It would seem desirable, however, to know the exact quantitative effect of each factor having an influence on the deflection, so the information could be summarized in one or more formulas, and it is hoped that experimental work may be continued with this end in view, particularly since such information would seem very desirable for use of the sub-committee dealing with specifications.

In this connection I wish to offer some thoughts as to the form the formula should take. Starting with soft iron without any hardening elements, the deflection under a given height of drop would be decreased with each increment of hardening material. It would be increased with an increase in the height of drop and decreased with an increase of the moment of inertia of the section and, perhaps, temperature of rolling should also be taken into account. The formula for deflection would then take the following form:

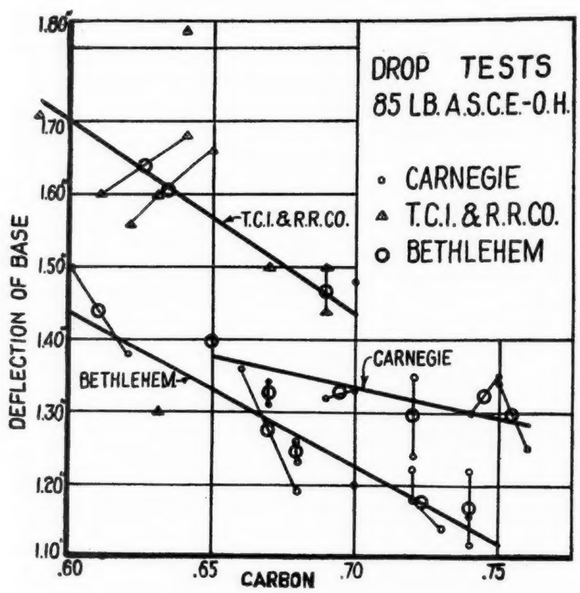
$$d = (K - cC - pP - mMn)\frac{h}{I}$$

where
d = deflection
K = constant for soft iron
C = carbon
c = constant for carbon
P = phosphorus
p = constant for phosphorus
Mn = manganese
m = constant for manganese
h = height of drop
I = moment of inertia

It is readily possible or even probable that the constant would change with different classes of steel, but the above form of the formula would probably be suitable for all of them, except we may find that the manganese factor may be omitted, and possibly also the phosphorus in special cases, and again, as stated, temperature of rolling may have to be reckoned with.



Location of Standard Test Pieces.



Influence of Carbon Content of Steel on Drop Test.

Appendix D.

A Study of Forty Failed Rails.

This report, made by W. C. Cushing, covers a study of forty rails which failed in the main tracks on the Southwest System of the Pennsylvania Lines West of Pittsburgh during the year 1909. The detail reports of the individual rails cover in most cases: 1. A statement of track conditions. 2. General photographs of the failure. 3. Photograph of the etched section. 4. Microphotograph in some cases. 5. Chemical analysis, from interior of head. 6. Physical test, from interior of head.

Sixteen broken rails were examined, and thirteen out of the sixteen were broken in or at the splices. Of these thirteen, two were Weber joints, one bonanza, and ten six-hole splice bar. Each of these rails was considerably worn in the splicing space, but the metal of five of them was hard and brittle, and in some cases the constituents were considerably segregated.

The result of the examination of twenty-four rails which failed from crushed or split heads showed that all of the failures were caused either by hard, brittle, unsound or segregated metal, or a combination of two or more of them. In three cases investigation showed that foreign material was rolled in the rail section. In one case it was very apparent that this foreign material was an old tie plate. The trouble appears to have occurred from the practice at the Gary mill of throwing pieces of scrap on the stool to prevent its cutting during the casting of the ingot.

Mr. Cushing concludes that these forty cases of rail failure point

out very clearly that the prime cause of rail failures is the poor quality of the material, as indicated by hardness, brittleness, segregation and unsoundness, all of which must be corrected in the ingot. Only two cases of faulty rolling were found in this lot.

A Study of Sixty-Eight Failed Rails.

This report covers a study of sixty-eight additional rails which failed on the Southwest System of the Pennsylvania Lines West of Pittsburgh, except a few which failed on the Rock Island System.

Figures below are percentages of total failures.

Weight of Rail.	Broken.		Head Failures.		Web Failures.		Base Failures.	
	Bess.	O. H.	Bess.	O. H.	Bess.	O. H.	Bess.	O. H.
100	20	19	58	40¾	14½	28¼	7½	12
90	17	34	74	50¾	6	12	3	3¼
85	16	21¼	69¾	63¾	6¼	9	8	6
80	15¾	15	73	60	6¼	19	5	6
75	28	..	51½	..	17½	..	3	..

From this study Mr. Cushing concludes that it is quite clear that the new rail sections, neither the P. S. section with the heavy head, nor the A. R. A. A. section with the thinner head, have yet brought about any improvement in the quality of the metal by reason of better proportionate distribution of the material in the head, web and base, respectively, in the hope that the conditions of rolling would be so improved as to produce sound material.

The defects must be remedied at the blast furnace, and the changes of improvement must bring about less segregation of the elements and smaller inclusion of gas bubbles and slag, in whatever way the results are to be accomplished, whether it be by more time for the mixing of the elements and the escape of the gas or in some other way not yet discovered.

In discussing Mr. Cushing's results, Mr. Wickhorst says that rail failures may be roughly divided in two classes, "broken" rails and "split" rails; the first class including square breaks, angular breaks, and perhaps also broken bases, and the second class including split heads and split webs. Broken rails, according to this lot of failures and the failures summarized on page 259 of part 1 of the 1910 Proceedings of the American Railway Engineering and Maintenance of Way Association, constitute about 30 per cent, and the split rails about 70 per cent of all rail failures. The material in about half of the broken rails shows satisfactory on test, while the material in the other half shows more or less defective. This means, it would seem, that poor quality in the rail is a contributory rather than a primary cause for the break.

The split rails generally show segregated material from the upper part of the ingot. In fact, this condition is so frequent that we may say that in general split rails are confined to this kind of material.

Appendix E.

Tests and Conclusions by M. H. Wickhorst.

Eleven reports have been made, covering the following subjects:

Nos. 1 and 2. Test of Bessemer Rails—Maryland Steel Company.

No. 3. Tests of Titanium Bessemer Rails—Lackawanna Steel Company.

No. 4. Tests of Bessemer Rails—Illinois Steel Company, South Works.

No. 5. Tests of Open-Hearth Rails—Gary Works.

No. 6. Tests of Bessemer Rails—Edgar Thompson Works, Carnegie Steel Company.

No. 7. Investigation of a Split Head Rail.

No. 8. Segregation as Influenced by Fire-Clay on Ingot.

No. 9. Strength of Rail Head.

No. 10. Drop Test of Rails—Effect of Impact Energy Variously Distributed.

No. 11. Flow of Rail Head Under Wheel Loads.

Drop Test.—The height of drop that a piece of rail will stand depends upon its position in the ingot. Starting from the top of the ingot, the height that is just sufficient to break the rail at first decreases until a "brittle zone" is reached, when the rail may only stand a few feet fall of a weight of 2,000 lbs. Passing this, the allowable height rapidly increases and remains roughly uniform for the rest of the rail bar. The heights called for in various specifications vary from fifteen feet to twenty feet. Close to the top of the ingot the rail may stand such a height, but in the brittle zone, with some makes of material, the rail may stand only five feet or less. In the lower part of the ingot the rail may be able to stand heights of forty to eighty feet, or even more. Just where the brittle zone is in different materials and with different size ingots has not been determined, but an extensive investigation should now be undertaken to work this out.

Segregation.—When molten steel is poured into the ingot the different constituents that compose the liquid mass do not stay together when solidifying, but the carbon, phosphorus and sulphur tend to collect or "segregate" toward the interior and upper part of the ingot. The region of maximum segregation seems to correspond in location with the brittle zone developed by the drop test. The tests indicate that a small amount of segregation is not harmful, but the allowable limit has not been determined.

The problem of ingot making apparently consists of controlling segregation as to maximum allowable limit, and as to location in the ingot, so a small discard will always remove it.

Split Heads.—It has been shown that at least some rail failures, such as are ordinarily classed as split heads, are due to excessive segregation, which results in very fragile metal in the interior of the rail, as explained in detail in report No. 7.

Pipes and Laminations.—Our tests show that laminations occur most frequently in rail from near the top of the ingot, but may occur in any part of the rail bar. They also show that laminations, in themselves, have no relation to the results in the drop tests. Some of the worst drop tests have shown no laminations, while the worst laminations noted have been attended by some of the best results in the drop tests.

Rolling.—Our work so far does not show definitely the influence of such matters as speed of rolling, number of passes in reducing from ingot to rail, temperature of rolling, distribution of rail sections, etc., but they indicate that such matters are of relatively small importance.

Conclusion.—In conclusion, our work of the last nine months has shown fairly definitely that the matter of making safe rails, and in which the different rails of the lot will wear uniformly, is almost entirely a matter of making a good ingot free from excessive segregation, or of cropping off sufficient from the top to remove such excessive segregation.

Investigation of a Split Head Rail.

This report covers a very interesting and instructive study and tests of a rail that failed due to a split head, and is intended to throw some light on the cause of failure. This rail was one of a number that failed in a somewhat similar manner in a lot of 80-lb. A. S. C. E. rails laid about October, 1909, by the Wabash R. R. on straight track in its main line near Adrian, Mich. It was a 33-ft. Bessemer rail of the Carnegie Steel Company, made at the Edgar Thompson Works at Braddock, Pa., in September, 1909, heat number 11508. It was removed from service in May, 1910. The rail has no letter showing its position in the ingot. The total tonnage over this rail was about 4.3 million freight tons and the passenger trains additional. The heaviest engines that ran on this rail weighed 103 tons, with a maximum weight of 14 tons per driving wheel. The bearing on the ties as shown by the rust marks on the bottom of the rail averaged 7½ inches and the tie spacing as determined by measuring from center to center of the rust marks averaged 22 in.

The examination consisted of etchings with copper potassium chloride of a large number of transverse and horizontal longitudinal section cut from the rail, chemical analyses, tensile tests of specimens cut from the rail and microscopic examination.

A rail in service tends to widen at the upper part of the head, that is, the upper part of the head extends transversely. The amount of widening varies considerably with different rails, some showing but little and others a large amount. The compressive effect of the rolling wheels evidently causes the metal to flow transversely, and this flowing seems always to be greatest at about the top of the rail. The metal at the top of the rail is practically always ductile material, but the metal in the interior of the head may sometimes be brittle and incapable of transverse extension, and in such a case, when the top flows and widens, the interior metal, as it cannot stretch likewise, must develop a crack. Of course, anything which takes away the ductility of the metal in the head in a transverse direction would allow of the formation and development of cracks, as for instance, slag enclosures, seams and laminations, due to gas holes and pipes, or bad segregation. In the case in hand the splitting of the head seems to have been due to bad segregation of the carbon and phosphorus. The metal seems to have been good metal in the ladle, but it evidently went to the bad in the making of the ingot, although the dangerous segregation could, indeed, have been removed with a sufficient discard from the top. This suggests that it would be desirable to make a somewhat comprehensive study of such matters as size and shape of ingot and other conditions influencing segregation.

After a crack has opened up, the metal above it, of course, tends to flow into it under the action of the wheel loads, and after this metal has reached the limit of its ductility in compression, it shears along diagonal lines, resulting in the "wedge" generally seen above a crack. The crack generally comes to the surface at the underside of the head at is junction with the web, although occasionally it runs down into the web and comes to the surface at the side of the web.

Segregation as Influenced by Fire-Clay on Ingot.

This report covers tests made to investigate the effect on segregation of putting fire-clay on the ingot directly after pouring. During the regular pouring of a heat of Bessemer steel of six ingots, two of the ingots were selected for test, one of which was without any covering, and the other of which was covered directly after pouring with a half-shoveful of fire-clay equal to about two pounds. They were made at the Edgar Thompson Works of the Carnegie Steel Co. at Braddock, Pa., on August 9, 1910, heat 5,101. Mixer metal and scrap steel were blown and poured into the teeming ladle, liquid spiegel being poured in at the same time. The metal was then poured at once into the molds, without any other addition. The ingots were 18½x19½ at the bottom. The stools and molds had been sprayed with a wash of fire-clay. The metal set quietly in both ingots. The uncovered ingot hardened quickly on top, while the covered ingot remained liquid on top for some time.

After being in the coaking pit for about 1 hr. 40 min., the ingots were bloomed to 9½x9½ inches, and instead of making the usual discard from the top, as little as practicable was sheared off. The usual practice at this mill is to cut the bloom into two billets, making the large discard from the top and a small one from the bottom. Each of these billets makes two rails. In the present case, as stated, only a small amount was sheared from the top, and the rails from the top billet were reserved for this investigation, which happened to be 90-lb. A. R. A. type B. section. Previous to rolling into rails, the billets were run through a reheating furnace.

The investigation consisted of drop tests, chemical analyses and etchings of sections. The A and B rails of each ingot were divided into units.

This study seems to show that with a Bessemer ingot weighing about 5,000 lbs. the effect of covering it with fire-clay directly after pouring is to cause the greatest segregation to go higher toward the top of the ingot and also to increase its concentration. A small discard, say less than 10 per cent, from the top, does not remove the zone of maximum segregation from either the plain or covered ingot, and the segregation would be worse in the covered ingot. A large discard of 20 per cent or over removes it more effectively from the covered ingot. This whole study, however, can be taken only as an indication and seems to show strongly the needs for a thorough study of the whole subject of ingot-making. Ingots of different sizes and shapes, made of both Bessemer and open-hearth steels and with different treatments, should be made and thoroughly studied, by testing the rails made from them and, what is perhaps more important, by also testing the ingots themselves. Etchings and analyses should be made of various ingot sections to determine accurately the distribution of the various metalloids and of cavities, slag, etc.

Strength of Rail Head.

This report covers tests made to determine the strength of the head of the rail with the load concentrated at the edge of the top surface. Tests were made with a 200,000-pound test machine by canting a piece of rail 18 inches long and applying the load at that edge by means of a block with a radius of 16½ inches to

represent a car wheel where it came in contact with the rail. Other tests were made with a reciprocating machine representing a loaded wheel rolling back and forth on the edge of the canted rail. These tests were made at Sparrows Point, Md., at the works of the Maryland Steel Company, who kindly furnished all the material and facilities for them, and were made especially for the sub-committee dealing with rail design. For these tests a rail was taken from stock and six pieces, each 18 inches long, were cut from it for test in the stationary test machine, and six similar pieces were used for test in the reciprocating machine. In order to have the material as uniform as possible throughout the section and in the different pieces a C rail was selected, that is, the third rail from the top of the rail bar. The rail was a 90-pound A. R. A. type B section and the pieces were planed down to thicknesses of head at the side of ⅜ in., ½ in., ⅝ in., ¾ in., ⅞ in., and 1 in., two pieces of each thickness, one for each kind of test. In each case the brand side of the head of the rail, which was the bottom side as rolled, was planed vertical to a width of 1 3-16 inch from the center line.

The arrangement used for making the stationary tests is intended to represent a 33-inch car wheel resting on the edge of the top of the rail. The head is thus tested as a cantilever, the load tending to sag the head locally and to also bend the web.

The load was applied in increments of 10,000 lbs. up to 60,000 lbs. and then in increments of 20,000 lbs. up to 200,000 lbs., the capacity of the test machine. The sag of the head was determined by measuring the distance by means of dividers, between prick punch marks placed on the side of the head near the bottom and on the base, the load being on while taking the reading. The marks on the base were placed about one inch from the web, by gouging some of the metal so as to have a vertical surface on which to prick punch the mark. The amount that the opposite side of the head elevated or the "lift" was determined in a similar manner.

The curves show that a load of 1,000 lbs. does not sag the head with the load applied to the edge of the top side, with any thickness down to ⅜ inch, and probably neither does a load of 20,000 lbs., although, as the load was on when the measurement was taken, we cannot say how much of the sag was elastic and how much permanent. A load of 30,000 lbs. seems to cause a permanent sag with the ⅜-inch head, but not much, if any, with the heads of greater thickness. It had been hoped to determine by these tests the maximum load which each thickness of head would carry, but it is now clear that in any future work of this kind the measurements should be taken after releasing each load, as well as while it is on, and it would also be desirable to make the measurements with a micrometer reading to .001 inch. With these changes it would seem that this test should give this information in a reasonably satisfactory manner.

It is interesting to note in this connection that the web seemed to stand the load of 200,000 lbs. successfully.

Tests were also made with a reciprocating machine in which a piece of rail is moved back and forth under a wheel to which a load can be applied by means of a system of levers.

Drop Tests of Rails.

The tests described in this report were made to compare the results of a given amount of impact energy, variously distributed, as, for instance, in one blow, and the same foot-pounds divided among several blows; also, for instance, the relative effects of tups of different weights, but with heights adjusted to deliver the same foot-pounds of impact.

The drop tests were all made with the base in tension, the rail being placed with its base downward on supports 3 ft. apart with radii of 5 in. The permanent deflection or set was measured both on the top side, including the depression caused by the tup, with a striking radius of 5 in., and on the base side, which latter measurement gave only the actual permanent bending of the rail.

Flow of Rail Head Under Wheel Loads.

The tests covered by this report were made to determine if possible, what change is made in the microstructure of the head of the rail by the rolling over the rail of heavy wheel loads. At the same time, measurements were made of the spread of the head and the width of the bearing produced. The tests were made at Sparrows Point, Md., at the works of the Maryland Steel Company, who kindly furnished all the material and all the shop and laboratory facilities to make them. They were made on the reciprocating machine by moving a piece of rail back and forth under a loaded cast iron car wheel. The desire was to simulate rather severe service conditions, and a light thin head rail was used. A 70-lb. Bessemer rail was selected from stock. and in order to have material fairly uniform throughout the section and in such several pieces as might be used for test, a "D" rail, that is, the fourth rail from the top of the rail bar, was used, heat 45.437 and fourth ingot of the heat. The piece of rail tested was 12 ins. long, which was set up between two other similar pieces, which acted as end pieces onto which the wheel could roll when leaving the piece under test. The piece tested had the sides of the head planed vertical to a width of head of 2 ins. This width was used partly to accentuate the test and partly to do away with the rounded corner, so as to allow of measuring the width closer to the top of the head, and the sides were made vertical so the measurements could be made satisfactorily with a micrometer along the whole depth of the head.

The test was started with a load of 30,000 lbs. applied to the wheel, using 1,000 double strokes or 2,000 rollings of the wheel over the rail under test. The bearing assumed a width of .64 in. The only effect on the width of head was to spread the top of the head .002 in., and the load was therefore increased at once to 60,000 lbs. and the test continued until the head seemed to no longer spread as measured with the micrometer.

It is also seen that under the conditions of this test and with the load and material used, about .8 of the maximum results was produced by the first 5,000 rollings, and almost the maximum by the first 10,000 rollings. The 22,000 rollings beyond this produced but little additional spreading of the head.

Discussion on Rail.

Mr. Churchill: Referring to the form for reporting rail failures, it is an important matter to show, in case of rail failures which side of the track the rail was taken from.

Mr. Lindsay: The section foreman's information is not always reliable. He will report that the track was all right, joints all right, road bed all right, yet, the rail broke. I believe we should have a question in there, "did the rail have a full bearing upon the tie plate?"

Mr. Churchill: I am a little afraid that we would get the same sort of an answer. I believe where a break occurs that is not very clearly explainable at first sight on the foreman's report, there should be an examination by somebody else much higher up than the track foreman, and I think that is the practice on most of the roads today. I am afraid, if we make our report too cumbersome, we will not get it answered in any intelligent manner.

Mr. Lindsay: Referring to the changes recommended in Form 405, I do not understand that it will be necessary to change our definition of a broken rail—"this term to be confined to a rail which is broken through, separating into two or more parts. A crack which might result in a complete break will come under this head." In consultation with the officer of Public Service in the state of New York on this subject, the definition of a broken rail, for the purposes of report to the state, read as follows: "For the purposes of this yearly report, a rail shall be considered as having broken when complete fracture into two or more parts has taken place, when there is any break in the head of the rail on the gauge side, or when there is any other break necessitating either the immediate removal of the rail from the track or its reinforcement."

Mr. Cushing: The classification as adopted by the rail committee is based on the common classification generally given by the men who see the failures in service and is intended to explain them as nearly as one would explain them by seeing them on the track. The person reporting this knows nothing about internal defects and consequently we have attempted to have the different classifications about as they are generally described. The information for the public service commission can be given from these reports by adding together several classifications given by the committee to make up what the public service commission calls a broken rail.

Mr. Lindsay: Conclusion 4 covers the general method of taking boring for chemical analyses. Last night we saw a section of an ingot showing the way segregation takes place. I would like to ask the committee if that segregation is reasonably symmetrical around the vertical axis.

Mr. Churchill: Yes, it is approximately so. The great mass of material at the bottom of the head brings the center of segregation or defective material, from whatever cause, near the junction of the head and the web. It of course extends down, as you saw in the picture, through the web and into the flange, but the web is so thin, if you attempt to take borings, you will get mixed material. For this reason, if for no other, the best location is near the base of the head, where you are sure to get a mass of material that is questionable, in a questionable rail.

C. E. Lindsay (N. Y. C. & H. R.): In looking over reports of causes of our broken rails I find that a very large percentage of the breaks occur on the left hand rail; as high as 90 per cent in some months. In looking further, I have been able to locate some defects due to defective equipment, and in tracing that up, I have reports of flat wheels passing over the road. Following that up, I always found that the car inspector's report showed that the wheel was examined before it left the terminal, and the flat spot was within the limits prescribed.

Would it not be possible to put a flat wheel on the machine that was shown last night for testing the pressure of wheels on the rail to see the effect of flats of different length on the rail and whether it is possible to break a rail with a flat wheel?

Mr. Wickhorst: That machine you saw illustrated last night moves at slow speeds, and we could not get the speed effect in it. Mr. Lindsay will find in the proceedings of the American Society for Testing Materials, several years back, some discussion I presented on the cause of breakages on the left hand side. The reason that is given there is that the locomotive is so built that when the counter-balance is down, giving the heaviest vertical load, the engine noses to the left at the same time.

E. F. Wendt (P. & L. E.): During certain months of the winter one hundred per cent of the broken rails occur on the left hand side of the track. The system of records now in use is so complete that we have before us this data.

Mr. Churchill: You are speaking of what must be classed as broken rails under the definition?

Mr. Wendt: I am speaking of rails actually broken and removed promptly.

Mr. Wickhorst: That preponderance of broken rails on the left hand side applies probably to what you would call cross sectional breaks or base breaks. It does not seem to apply to longitudinal breaks such as split heads. I have tried to notice that point in looking over track, and what little information I have secured indicates that it does not make much difference with the latter class of breaks.

W. H. Elliott (N. Y. C. & H. R.): The data on the blow or pressure on the rail for various points of counter-balance of a locomotive wheel were worked out very fully in 1892 in the proceedings of the Master Mechanics' Association. It was then shown, as I recall it, that the left forward driver of an American locomotive is the heaviest of the four driving wheels, but there did not appear to be a difference in blow delivered on the rail to account for such great difference in the breakages between the left and right hand rail. I would suggest that this matter be taken up with the Master Mechanics' association by our committee, and the blow or weight of the wheels for the drivers of the Pacific type of engines be determined. This matter, I believe, was very fully considered by that association in connection with the wear of tires to account for the driving wheels almost universally wearing more at a certain point midway between the crank position and the counter-balance. It is not directly opposite the counter-balance, but a little ahead of it.

R. N. Begien (B. & O.): This is a matter which we now have under consideration. We have noticed, on our Chicago Division, that practically 90 per cent of breakages in the rails occur on the left hand side. Possibly the use of a heavier rail on the left hand side might be better.

Mr. Kenly: The thought occurred to me that probably the broken rails on double track result from loose, or relatively

loose track, on the inside rail, due to the fact that the track is not so well drained at the middle between the double tracks, as it is on the outside, and that probably the number of loose ties, or loose heads in the inside rail on the double track, is more the cause of the broken rails than is the thrust, or impact of the engine on the left hand side. I do not know whether we have any information to show that there is more bad surface on the inside rail than on the outside rail, but it occurs to me that that is the cause for broken rails in the case of double tracks.

The President: The committee suggests that is a matter for investigation by the committee on track.

Mr. Churchill: In the matter of specifications, we are somewhat in the same position we were a year ago. We have not gotten much closer. The difference, however, was not very great and we expect during this year to get together. As to the matter of rail sections, we cannot determine at this date with so few rails of the newer sections in use for such a short time which are better, but these reports that are coming in and will come in during this year, and the additional investigation by Mr. Wickhorst and by others interested will help us.

Mr. McDonald: In the matter of the testing of rail joints, I have heard it stated by representatives of manufacturers that some of the joints submitted had been specially prepared for that test and that others had not. I think in order to avoid that, it would be well in future for the committee to select their samples from the general run rather than have any special samples.

Mr. Churchill: I think in every instance the joints were taken from stock. There was probably one instance of a joint that came from a manufacturer. Any joint that happened to be in the storehouse was taken on my road. I know that other roads did the same thing. If our report points to anything it is the importance of looking out more carefully for the character of the steel used in rail joints, whoever makes the joint.

TRACK.

The following sub-committees were appointed:

Frogs and Crossings: L. S. Rose, chairman; J. C. Nelson, R. M. Pearce, R. H. Howard, C. H. Stein, R. C. Falconer.

Switch Points: H. T. Porter, chairman; S. S. Roberts, P. C. Newbegin, G. J. Ray, R. A. VanHouten, J. R. Leighty, T. H. Hickey.

Track Fastenings with Treated Ties: Dean Wm. G. Raymond, chairman; Garrett Davis, F. A. Smith, W. D. Wiggins, J. L. Downs.

Spirals: J. B. Jenkins, chairman; Dean Wm. G. Raymond.

Revision of Manual.

After giving that portion of the Manual pertaining to track much discussion, it was decided that changes be recommended as follows:

(1) Maintenance of line, section (b), for the adjustment of curves, should be changed to real as follows:

"Longer easement curves than the minimum lengths recommended may be used to advantage, and even with increased convenience in their application, but any considerable increase in length is wholly unnecessary and should never be made without careful consideration as to the effect on cost. For minor curves, an increase in length of about 50 per cent over the minimum is recommended when such increase will not seriously affect the cost, nor adversely affect the degree of curve. The minimum length recommended should be used in all cases where greater length would adversely affect the degree of curve."

(2) Following the last paragraph under section (b), the following should be added:

"The 10-chord spiral, computed by dividing the spiral into 10 equal parts, is recommended. Chords of any length may be used in staking out the 10-chord spiral when the central angle is small. Chords approximating one-tenth the length of spiral should be used when the central angle exceeds 15 degrees."

(3) Maintenance of Surface. The third paragraph following the table of elevation of the outer rail should read as follows: "Ordinarily an elevation of eight inches should not be exceeded. Speed of trains should be regulated to conform to the maximum elevation used."

(4) Maintenance of Surface, section (a), recommended practice. The following paragraph should be stricken out: "In ordinary practice it is recommended that the elevation be run out at the rate of one inch in 60 feet, but this will be modified by the same conditions that would vary the length of the easement curve used."

(5) Maintenance of Gage, section (a). Paragraph 1 should read as follows: "Tie plates are recommended in all cases where economy in maintenance will result from their use."

Instructions for Ordering Frogs, Crossings and Switches.

Manufacturers shall submit for approval detail shop drawings showing construction and dimensions of all parts to be furnished in accordance with these specifications. The drawings shall be on sheets twenty-two (22) in. wide, with a border line one-half (½) in. from the top, bottom and right-hand edge, and one and one-half (1½) in. from the left-hand edge. The standard length of drawings shall be thirty (30) in., except that, when necessary, longer sheets may be used and folded back to the standard length.

Drawings of one subject only shall appear on a sheet.

Scale of general drawings shall be 1½ in. = 1 ft., details not less than 3 in. = 1 ft. Conventional shading shall be used in sectional drawings. All dimensions and distances shall be shown plainly in figures.

The title shall be placed in the lower right-hand corner.

All drawings are intended to form a part of the specifications. Anything which is not shown on the drawings but which is mentioned in the specifications, or vice versa, or anything not expressly set forth in either, but which is reasonably implied, shall be furnished the same as if specifically shown and mentioned in both. Should anything be omitted from the drawings or specifications which is necessary for a clear understanding of the work, or should any error appear in either the drawings or specifications affecting the work, it shall be the duty of the manufacturer to notify the company and he shall not proceed with the work until instructed to do so by the company.

Switches.

Lengths.

1. 11 ft., 16 ft. 6 in., 22 ft. or 33 ft.

Throw.

2. 5 in. at center line of No. 1 rod.

Gage of Track.

3. 4 ft. 8½ in.

Switch Rails.

4. Side planing and bending shall conform to a spread at the heel of 6¼ in. between the gage lines of the stock rail and the switch rail. The gage lines of switch rails shall be straight. The head of switch rail shall fit neatly against the head of stock rail from point of switch rail to point of divergence. The face of web at the point shall be in a vertical line with the inside of the head of stock rail.

Top planing shall conform to the measurements shown in Table 1. "AB" is the distance from the end of the switch point to end of top planing.

TABLE 1.

Switch.	A B.
33 ft.	12 in.
22 ft.	9 in.
16 ft. 6 in.	5 in.
11 ft.	5 in.

Bottom of switch rail shall be planed to fit neatly on base of stock rail where bases overlap.

The point of switch rail shall be as shown in illustration.

Holes for switch rod lugs and stop blocks shall be 25/32 in. in diameter and 5 in. center to center. Holes for reinforcing bars shall be 25/32 in. diameter. Number and location as provided under Reinforcing Bars.

Lugs.

5. Lugs shall be as deep as the section of rail will permit and of standard design. Distance between centers of holes for bolts running through the web of the rail shall be 5 in., diameter of holes shall be 25/32 in.

Distance between web of rail and center of switch rod bolt holes shall be 5 in. Switch rod bolt hole shall be 11/32 in. in diameter.

Switch Rods.

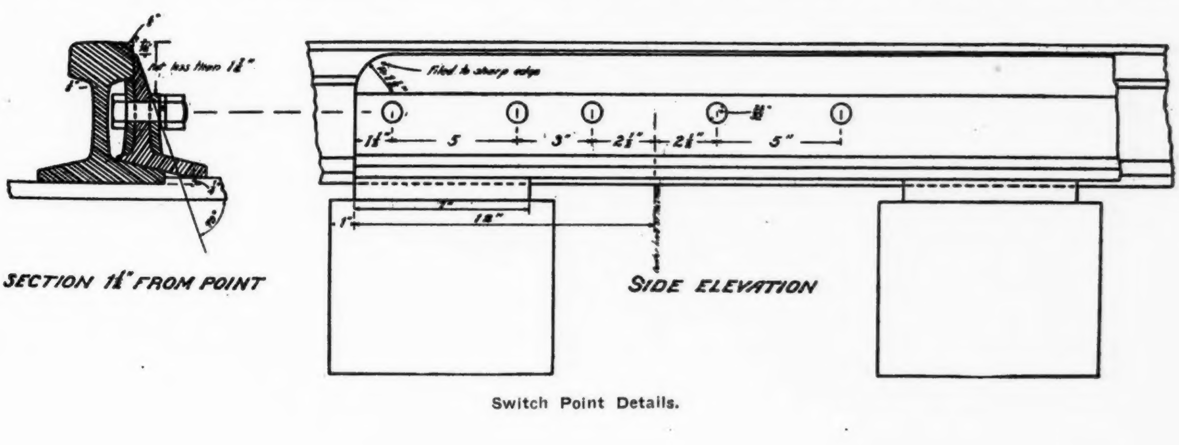
6. Switch rols shall be of the standard design. Rods shall be ¾ x 2½ in. and shall be held in a horizontal plane. Bolt holes shall be 11/32 in. in diameter. There shall be at least 1½ in. of metal at end beyond bolt holes.

Rods shall be stamped with ¾-in. letters showing the weight, section of rail and number of rod, the point rod being No. 1.

Reinforcing Bars.

7. A reinforcing bar ⅜-in. thick shall be riveted to each side of each switch rail and point ends shall be made flush with point of switch rail. The bars shall be as long as the heel connections will permit. Bars shall fit against web of rail and shall fill the space between head and flange of rail. There shall be ⅛-in. clearance between outer bar and head of stock rail where the bar projects under head of stock rail, and the top of inner bar, where it projects beyond the head of switch rail, shall be not less than 1⅞ in. below the top of stock rail.

Bars shall be fastened to rail with ¾-in. rivets, except that the first, second, fifth and the holes through which the lugs are fastened shall be bolted. Center of first hole shall be 1½ in. from point and



Switch Point Details.

center of last hole in bar to be 2 in. from heel end of bar. Intermediate rivets shall be spaced so that there shall be fastenings at intervals not greater than 12 inches.

Stock Blocks.

8. Stop blocks shall be of approved design with two holes 13/16 in. in diameter and 5 in. apart. Blocks shall be spaced after switch is placed in track as nearly as practicable at equal intervals between the end of planing and heel of switch.

Bolts and Nuts.

9. Bolts which fasten lugs, stop blocks, and foot guards to switch rails shall be ¾-in. in diameter. Bolts connecting lugs with switch rods and the switch-stand connecting bolt shall be 1 in. in diameter and machine turned. All bolts shall be provided with nut locks and cotters. Nuts shall be hexagonal.

10. There shall be on each tie two plates, ⅜-in. by 7 in., planed down to receive the stock rail and braces. Three 13/16-in. holes outside and two inside are required for ⅞-in. lag screws or screw spikes on all switch ties, except the two head ties, where there shall be three outside and four inside.

Braces.

11. Braces shall be of such a design that 2½-in. clearance for detector bars may be obtained. Three holes for ⅞-in. lag screws or screw spikes shall be provided.

Specifications for Manganese in Frogs, Crossings and Switch Points.

The committee has investigated so far as has been practicable this year the question of specifications for manganese in frogs, crossings and switch points, but thinks that this subject should be further investigated and that careful records and experiments covering a period of years should be recorded before it is in a position to recommend a specification that will meet with approval.

Track Fastenings with Treated Ties.

The following statements seem to be warranted by a study of the replies to circular letters:

(1) Tie-plates with some form of fastening which can be removed and replaced at will without injury to the wood fibers are desirable. Your committee feels that such fastening has not as yet been fully demonstrated.

(2) In shoulder tie-plates the holes for outside fastenings should be so placed that the base of the rail bears only against the body of the fastenings.

(3) Tie-plates should be flat-bottomed, as projections of any kind tend to destroy the tie. One striking photograph is shown of a treated bridge tie entirely sound except where the projections of the plate have injured the fiber. This effect would perhaps be lessened if the tie-plate were independently fastened to the tie by screws other than the rail fastenings, and by use of the principle mentioned in paragraph 5.

(4) The bearing surface of tie-plates should be proportioned by each road to the resistance of the wood most largely used for ties on its line. In general, plates six inches wide for hard woods and seven inches wide for soft woods should be sufficient, but some roads report trouble with plates of these widths.

(5) A tie-plate thicker through the whole or a part of the middle of its length than at the edges, with only a central bearing, is suggested for trial as theoretically sound. There would be less tendency for such a plate to rock under the action of the passing load and less pressure tending to force first one edge and then the other into the tie, and the plate would be strongest where the bending moment is greatest. The essentials of such a plate are the thicker central portion and the central bearing of the rail.

CONCLUSIONS.

The committee recommends:

(1) That the changes in the Manual, as proposed, be adopted.

(2) That the title of the specifications for spring and rigid frogs adopted by the convention of 1910 be changed to read: "General Specifications for Frogs, Crossings and Switches."

(3) That the General Instructions for Ordering or Contracting for Frogs, Crossings and Switches, as given in the report, shall be prefixed to the specifications mentioned above.

(4) That the plans for rigid and spring frogs, submitted with the report, be adopted and added to the specifications for the frogs, crossings and switches.

(5) That the specifications for switches submitted be adopted and added to the specifications for frogs, crossings and switches.

(6) That the report on Track Fastenings used with Treated Ties be accepted as a progress report.

(7) That the report on Spirals be adopted.

The report is signed by: C. E. Knickerbocker, N. Y. O. & W., chairman; J. B. Jenkins, B. & O., vice-chairman; Garrett Davis, C. R. I. & P.; J. L. Downs, Y. & M. V.; R. C. Falconer, Erie; T. H. Hickey, M. C.; R. H. Howard, Chicago, Ill.; C. B. Hoyt, N. Y. C. & St. L.; John R. Leighty, M. P.; J. C. Nelson, S. A. L.; P. C. Newbegin, B. & A.; R. M. Pearce, P. & L. E.; H. T. Porter, B. & L. E.; G. J. Ray, D. L. & W.; Wm. G. Raymond, State University of Iowa; S. S. Roberts, Louisville, Ky.; L. S. Rose, C. C. C. & St. L.; C. H. Stein, C. R. R. of N. J.; F. A. Smith, Civil Engineer, Chicago, Ill.; R. A. Van Houten, L. V.; W. D. Wiggins, Pennsylvania.

Appendix A.

Spirals.

A preliminary examination was made of a number of curves to determine their relative adaptability for use as a railroad spiral, the examination comprising the cubic parabola, a curve whose deflections vary as the square of the distance, the Searles spiral, the Stevens six-chord spiral, a curve whose radius is inversely proportional to the length of arc, as developed by Crandall and Talbot, a curve whose degree increases with the number of 100-ft. chords, and a curve whose chords subtend a constant and inflexible series of central angles. All the above curves accomplish the required results in easing the approach to a circular curve, some less perfectly than others, but still satisfactorily; but in attempting to derive formulas for the various spirals, some one of the following difficulties was experienced in each case: (1) If simple, approximate formulas were used they were not sufficiently accurate. (2) Accurate formulas were too complex. (3) The curve could not be expressed by formulas. (4) Formulas were of the endless-series class. (5) Complex field methods were required to make the field work agree with formulas with spirals of large central angles.

The committee then investigated a practical adaptation of the spiral as developed by Crandall and Talbot in which the curve is considered to be measured by ten equal chords; this curve was found to be susceptible to expression by definite formulas which compare favorably as to simplicity with those of other spirals, the formulas being accurate beyond the degree of accuracy attainable in the most careful field work if the application of the formulas be restricted to such spirals as may actually be required in practice. Tables developed from this formula were presented.

The committee also submitted a diagram indicating graphically the minimum length of easement curve as recommended by the association.

The committee recommends the following changes in the Manual:

Maintenance of Line and Alinement.

(b) Adjustment of curves, with consideration as to easement curves:

Longer easement curves than the minimum lengths recommended may be used to advantage and often with increased convenience in their application, but any considerable increase in length is wholly unnecessary and should never be made without careful consideration as to the effect on cost. For minor curves, an increase in length of about 50 per cent over the minimum is recommended when such increase will not seriously affect the cost, nor adversely affect the degree of curve.

The minimum length recommended should be used in all cases where a greater length would adversely affect the degree of curve.

(Following the last paragraph.)

The ten-chord spiral, computed by dividing the spiral into ten equal chords, is recommended. Chords of any length may be used in staking out the ten-chord spiral when the central angle is small. Chords approximating one-tenth the length of spiral should be used when the central angle exceeds fifteen degrees.

Discussion on Track.

Mr. Knickerbocker: In article 3, "Maintenance of Surface," under "Revision of Manual," we wish to have that part of the second paragraph which appears in italics stricken out. The words are: "Speed of trains should be regulated to conform to the maximum elevation used."

In section 2 of the statements on track fastenings with treated ties, we want to insert between the word "rail" and the word "bears" in the second line the two words "does not" so that it will read: "Rail does not bear."

In formula No. 13, under spirals, the T should be T sub S.

In the same portion of the report, the E in the last line of the table of notation should be E sub S.

Under A B in table I, under general instruction for ordering frogs, crossings and switches, the dimensions should be feet instead of inches.

Mr. Lindsay: May not the words "are intended" in the beginning of the 5th section be omitted?

The Chairman: The committee will omit the word "intended."

G. H. Tinker (N. Y. C. & St. L.): It does not seem to me that the first and last paragraphs of the introduction are quite consistent. The last paragraph says that all drawings are to be a part of the specifications. The first paragraph says the manufacturers make the drawings. If the railway company made the drawings, all right. It seems to me that is the proper procedure in any case. Our road makes its own plans, submits them to the manufacturers, and the manufacturers proceed according to the plans, and in that case they are a part of the specifications.

Mr. Knickerbocker: A great many railways cannot afford to make the plans, and these railways ask the manufacturers to submit plans for certain crossings, and they do it. Many railways do not have the opportunity to make these plans, and sometimes they are in a hurry for the crossing and cannot wait to make the plans, and they ask the manufacturer who makes the crossings to submit a plan with a proposal for furnishing the crossing, and it is a quick way to obtain a crossing, which you cannot get in any other way.

J. P. Snow (B. & M.): There is a distinction between the first and last paragraph. The first paragraph recites that the manufacturer shall make his own shop drawings, because his shop nomenclature differs from the practice of others, and for this reason he is called upon to make detailed shop drawings. The last paragraph refers to drawings made by the railway company, which may be nothing but a line drawing showing the layout of the crossing.

Mr. Lindsay: In connection with the paragraph on switch rails we will have to take into consideration the drawings which do not show the bend in the stock rail, and therefore are not complete. The web has two faces, and I think it is proper to say that the outer face of the web shall be in a vertical line with the inside edge of the stock rail. It would be better, however, if the words "gage side" were used.

Mr. Knickerbocker: We found in some cases, where the manufacturer did not put in a stock rail, and we had to put that in the track, that the distance from the bend in the stock rail is not uniform. That is matter for consideration another year.

Mr. Lindsay: I move that the committee be instructed to define the bend in the stock rail.

Mr. Rose: If a manufacturer has the point of the switch rail itself given to him, he does not need to know where the stock rail is bent.

Mr. Byers: I move to amend Mr. Lindsay's motion to the effect that the committee be asked to report on this question of the bend of the stock rail as an independent proposition later. Upon vote, amendment to the motion was defeated.

Mr. Rose: If it will satisfy Mr. Lindsay I think we can add to these drawings the distance from the toe of the switch to the bend in the stock rail as previously figured out by this committee, and that can be readily added to these drawings.

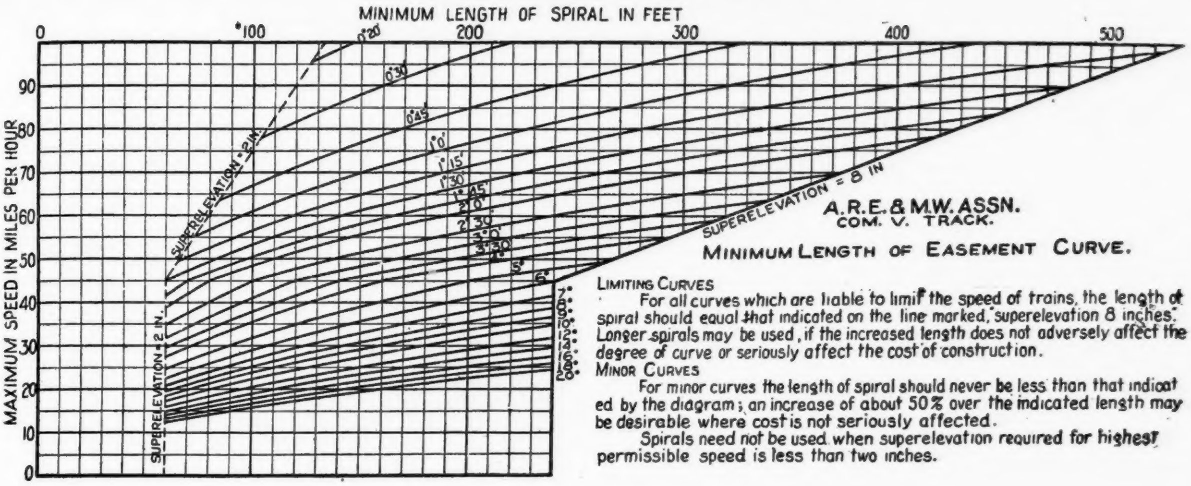
Mr. Lindsay: That is satisfactory.

A motion to insert the words "inner face of the" between the words "between" and "web" was carried.

Mr. Kenly: I would like to ask if the committee has investigated the proposition to make all of the switch rods exactly the same length between the bolt holes and vary the distance from the web to the center of the hole in the lug for the different weights of rail?

Mr. Knickerbocker: We have thought about that a great deal.

Mr. Lindsay: I move that in clause 7, the distance of one-eighth It would be an advantage for the lugs to be marked. inch be increased to one-quarter inch, and that after the words "top of stock rail" there be added "The reinforcing bar shall be beveled to an angle of 45 deg. where it projects beyond the head of the rail. That is the New York Central practice at the present time. The motion to increase clearance was lost. The committee accepted the insertion suggested by Mr. Lindsay.



Minimum Length of Easement Curves.

B. H. Mann (Mo. Pac.): I would like to know if there would be any objection to changing the sketch of switch point details to show the complete length of the point. Then, if a 16 ft. 6 in. point becomes broken, so that it can be planed down to a point that is 11 ft., all that will be required will be to cut the reinforcing bars, using the same holes for the rivets with the new length and at the same time the interlocking feature will be protected.

Mr. Knickerbocker: We would like to do that but until we can determine whether we can use the same distance from the point to the center of the throw rod of a hand thrown switch as with an interlocked switch, we cannot do it.

W. H. Elliott (N. Y. C. & H. R.): The drilling shown in the diagram is the best from the standpoint of the signal engineer. It provides for the best possible signal construction and enables us to better support the point than we can with the drilling which has been used.

A motion that the committee provide in the plates which go on the two head block ties two holes in each plate of the proper dimension and properly located so that the switch can be spiked when disconnected from the switch-stand or from the interlocking apparatus, was carried.

E. F. Wendt (P. & L. E.): I would not like to see an action taken which would commit the association to a standard which might be used in court against the railway company. The switches as proposed are the very best that could be designed from the standpoint of slide plates and braces. There are few railways in this country, if any, which use switches of this standard, because these switches are of a much higher standard than are now in use in America. You will notice that the tie plates extend two ties beyond the heel of the switch. There may be only one, one or two, or possibly three roads in the country that have a standard of that kind, and while I admit it is the best standard, there certainly can be but very few roads that go that far. If it is necessary to burden the railways with all the expense for additional slide plates and additional braces, let us say so, and then let us advocate the appropriation of the money for the work. We do not spend the money for switches of this standard, however, and I take the position that this extreme number of braces for one point is unnecessary from the standpoint of safety. I am using this point simply by way of illustration, so that we may not commit ourselves to any standard which might be used in a court against the railway companies.

Mr. Patenall: If railroads do not follow improved methods, I am afraid we would get into a bad state of retrogression. However, I do not see that we are taking any great responsibility, in point of law, by applying such improvements as may become necessary, and I believe the committee ought to be sustained in its report.

L. S. Rose (C. C. C. & St. L.): I think if we follow that reasoning to the limit, every action we take would come under the same heading.

Mr. Knickerbocker: Some railways use two tie plates with two spikes and some with three spikes. There are other roads that use the tie plates with brace on each end. We took the position in our report that we thought was proper. We cannot get a general standard to fit all conditions.

H. T. Porter (P. & L. E.): We were not asked to get up a switch that would simply be safe. We could have gotten up one very much similar that would be safe under reasonable inspection as switches get on a railway, but we did try to design a switch that would ride smoothly and comfortably, as far as we were able. We also endeavored to design a switch that had the longest possible life. Railways are gradually adding more rail braces to their switches.

W. M. Camp: I think the committee is rather extravagant in the use of rail braces. The object of rail braces at a switch is to take the unusual side thrust of the locomotive or car in taking the switch, and that comes at the point where the track changes direction, and according to my observation it is not usual to have braces all the way to the heel of the switchpoint, especially when rails 33 ft. long are used. I do not see how safety is promoted by having braces back of the rod which comes at the end of the planing. All of the force of the thrust comes against the stock rail on one side and the through rail on the other side when the train takes the switch. That is the part to be protected. It looks more substantial to see braces running back to the heel joint, but I do not consider that it is any safer than to omit, say, half the braces on the 33-ft. point. Two spikes can be put down through the plates which will hold the rail very securely.

A motion to adopt the amended conclusion was lost.

A motion to adopt the recommended drilling of the switch point included in the general instruction for ordering, was carried.

A motion to receive the conclusion as information was carried.

The fourth conclusion was received as information.

Prof. A. N. Talbot: In the report on spirals, I desire to suggest two slight modifications in the table of deflection coefficients. Instead of the word "deflections" in the heading, substitute the words "deflection angles." The table should be changed in form so that the coefficients read down the column for the transit at any given point instead of across the page. This will be very much more convenient for use.

Mr. Cushing: The suggestions are accepted.

Prof. Talbot: In the upper left-hand part of the diagram of minimum length of easement curve is given a limit of length of curve for superelevation of two inches. It will be seen by using these formulas that the amount of throw of track from what it would be for a tangent and circular curve is less than one-quarter inch for all of those opposite that particular dotted line. The last sentence of the printed matter reads: "Spirals need not be used when superelevation required for highest permissible speeds is less than two inches." I would suggest the addition of the sentence: "Nor when the distance between the tangent and the parallel tangent of the offset of curve is less than 0.2 ft." I am not anxious about that particular value.

Mr. Jenkins: Taking thirty-minute curves at a speed of about 80 miles an hour, I think a spiral would be preferable there, because it would greatly reduce the shock of contact between the flange of the wheel and the outer rail, and in fact for any lighter curves than one degree at speeds of about 60 miles an hour the same thing would be true. The committee covered that point last year in a discussion of the effect of the very short spiral when the offset was slight and cut that out where the spiral would not govern the path of the wheel at all, but where the spiral would produce any effect on the motion of the train, it was introduced. A great many spirals ought to be introduced in all cases, regardless of how small the offset is. In the answers we received some favored the spirals in all instances and some favored spiral distance of .01 to the foot instead of 0.2. The committee took 0.04 as about the minimum.

Prof. Talbot: I would like to make sure that this association feels that the track can be put down at 0.01 ft., as just mentioned, and that it would pay to put down a spiral where the track would not be shifted from a tangent and circular curve more than 0.02 of a foot, or ¼ in.

A motion to add the sentence suggested by Prof. Talbot was lost.

Mr. Jenkins: For light spirals, it would make very little difference whether we use the formulas derived by Prof. Talbot or Prof. Crandall, or some others. When you come to spirals of high central angle, then the character of the formulas makes considerable difference and there are certain approximations that will apply also to all spirals of small central angle. If you try to make the same formulas apply to spirals for a one degree curve, or a spiral 300 feet long to a one degree curve, and try to make the same formulas apply to a spiral 200 feet long, to a 20 degree curve, the formulas will not apply at all. The track committee has obtained formulas that will apply in all cases up to the practical limit of 45 deg. total central angle.

A motion to express to the committee the thanks of the association for its work was unanimously carried.

MASONRY.

The following sub-committees were appointed:

Revision of Manual: Richard L. Humphrey, A. H. Griffith, G. H. Scribner, Jr.

Waterproofing of masonry, covering methods, results, cost and recommended practice: George H. Tinker, L. N. Edwards, W. J. Backes, F. E. Schall, F. L. Thompson.

Define monolithic construction; revise report on durability of all monolithic construction in arches or large abutments with wing walls: W. H. Petersen, C. W. Boynton, Job Tuthill.

Typical plans of retaining walls and abutments, plain and rein-

forced, with comparison and recommended practice: T. L. Condron, W. W. Colpitts, B. Douglas, R. T. McMaster.

Investigation and report on the use of reinforced concrete trestles, typical designs and cost: A. N. Talbot, C. H. Moore, G. J. Bell.

Recommendations for next year's work: Entire committee.

To co-operate with the joint committee on standard specifications for cement: Howard G. Kelley, C. W. Boynton, C. H. Moore.

To co-operate with the joint committee on concrete and reinforced concrete: C. W. Boynton, L. N. Edwards, A. H. Griffith, F. E. Schall, G. H. Scribner, Jr., F. L. Thompson, Job Tuthill.

Revision of Manual.

Minor changes in wording were made and the following new paragraph was added to the recommended practice for designing reinforced concrete structures:

"Shrinkage and temperature reinforcement: Reinforcement for shrinkage or temperature stresses, in amount generally not less than one-third of 1 per cent, and of a form which will develop a high bond resistance, should be placed and be well distributed near the exposed surface of the concrete."

Waterproofing of Masonry.

A circular requesting information concerning current practice in the waterproofing of masonry was sent to the members of the association, this circular being substantially a duplicate of circular 122, issued at the request of the committee in 1909. Fifty replies were received, of which 27 contain no information. Some of the replies contain detailed descriptions of structures. An abstract of all replies containing pertinent information is presented with this report.

The 1909 replies included very little information as to cost. It was thought that its publication might lead to unwarranted conclusions. More replies have been received this year, but the conditions are so widely different that hardly any two replies cover the same conditions. Under these circumstances an average cost for any one type of waterproofing would likely be far from the true cost. It is also evident that several of the figures are erroneous, sq. ft. and sq. yd. having been confused, each figure should be considered in connection with the particular example to which it refers.

The masonry structures usually waterproofed are the floors of solid-floor bridge and arches over city streets, to prevent the leakage of ballast water; roofs and walls of subways, to prevent the leakage of ground water; basement and building walls, concrete roofs of buildings and retaining walls, to prevent the leakage of rain or ground water; reservoir and tank walls, to prevent loss by leakage.

The subject of waterproofing may be considered from two points of view. It may be an investigation as to the imperviousness of various substances or it may be an investigation of the methods of treating certain masonry structures so as to prevent the leakage of water through them. The first is a laboratory problem and has not been touched by the committee. The second is a practical problem and is the one considered by the committee. There is involved, in a report upon the condition of a structure from this point of view, the element of suitability to use and also the personal equation of the person making the examination. A reservoir wall may be permitted to leak a few gallons daily; a bridge floor must not allow water to drip; in some situations a stain or discoloration would be objectionable and must not be allowed. Different observers might report compliance with any of these conditions as "perfectly satisfactory." In comparing different methods of waterproofing this element must be eliminated.

Another table was presented, grouping the information shown in four general classes. Class 1, designated as "exterior envelopes," included all those processes of waterproofing by which the masonry is covered with a thick coating of more or less impervious material, generally applied in several layers and generally including tarred felt or similar fabric or burlap. The waterproofing materials used are coal tar pitch and asphalt or bituminous products of petroleum. Class 1 was further divided into four subheads: "a" including all examples of the use of felt and coal tar pitch; "b" felt and asphalt; "c" burlap and either pitch or asphalt; "d" mastic, this being a bituminous material mixed with sand and concrete and applied in one or more thick layers. Class 2 included examples of materials mixed with concrete. Class 3 was designated as "exterior coatings," and included all those coatings of the nature of washes or paints. Class 4 comprised those examples in which no waterproofing is used.

In class 1, out of a total of 23 examples under subdivision "a" 13 showed no leaks, 2 leaked slightly, and 8 leaked badly; out of a total of 55 examples under subdivision "b" 16 showed no leaks, 9 leaked slightly, and 30 leaked badly; out of a total of 13 examples under subdivision "c" 5 showed no leaks, 4 leaked slightly, and 4 leaked badly; while of the 5 examples under subdivision "d" 1 showed no leaks, 2 leaked slightly and 2 leaked badly. With 8 examples in the second class, 5 showed no leaks, 1 leaked slightly, and 2 leaked badly. In the third class out of a total of 42 cases 6 showed no leaks, 9 leaked slightly, and 27 leaked badly. Out of 4 examples in class 4, where no waterproofing material was used, 1 showed no leaks and 3 leaked slightly.

A study and analysis of the replies indicate:

(1) No method of waterproofing has proved entirely satisfactory.

(2) Some cases are reported in each class showing no leaks.

(3) The difference in efficiency between the various classes does not appear to be great. It does not appear to what extent success is due to the quality of the masonry.

(4) Failures are due to faulty details, poor workmanship, poor materials and the formation of cracks in the masonry.

(5) To secure dry work, it is necessary that details should be carefully designed; this includes the details of the masonry as well as of the waterproofing. The materials must be carefully placed by skilled workmen. The supervision must be constant and efficient. Shrinkage and temperature cracks should be prevented by reinforcement.

(6) Concrete masonry designed and placed as above indicated, with properly designed temperature and shrinkage reinforcement, may be made waterproof without the addition of special waterproofing materials.

Monolithic Construction.

Monolith of Concrete.—A single mass of concrete made without joints by a continuous operation of construction.

Monolithic concrete construction is the building of a single mass of concrete without joints by a continuous operation.

In order to judge of the merits of monolithic construction we should examine the various causes which bring about the failure of masonry construction to ascertain whether or not monolithic construction will either prevent or delay failure when masonry is subjected to conditions that are likely to occur during their lifetime.

Below are given causes for various masonry failures as taken from reports of various railroads, and a report by Prof. Swain, which was gathered from various periodicals for the use of the committee:

(1) Faulty Design: (a) Where masonry is placed on grillage above the water line, the grillage rotting and allowing masonry to settle. (b) Where grillage rests on piling and where the designer used too high a unit stress for timbers in compression. (c) Where U-abutments have their wings built too light. (d) Where the designer has allowed too high a unit pressure on the earth in front of the abutment or on piling upon which it may rest. (e) Settlement which frequently causes a crack to appear where the wing leaves the main portion of the abutment. (f) In case of arches, the wings sometimes separate from the body of the arch or the arch will frequently crack from 10 to 20 ft. on each side of the center line of the track, depending upon the height of the fill. (g) Lack of proper drainage.

(2) Poor material or poor workmanship.

(3) Temperature cracks.

(4) Disintegration of the masonry: (a) On account of the freezing and thawing of exposed surfaces of masonry, particularly where water drips through an arch ring or where the masonry near the ground is exposed to alternate freezing and thawing. (b) On account of masonry being exposed to salt water, alkalies, acids or heat.

(5) Improper filling.

(6) Scouring Away of the Material Underneath the Masonry: (a) On account of unusual freshets. (b) On account of driftwood, wagon bridges, etc., lodging against the masonry. (c) Account of ice gorges. (d) Account of the size of the opening being too small, whcih causes the water to rise during a freshet and which increases the velocity of the stream sufficient to scour away the material underneath the masonry.

(7) Material sliding and carrying the masonry with it.

Cause 1.—If the settlement in cases (a), (b), and (d) was not uniform in a large monolithic structure they would probably crack unless they were reinforced so as to prevent settlement cracks. If the structure was an ordinary single-track abutment up to about 20 or 25 ft. in height it would probably settle without cracking. If the abutments were built in sections the different sections would be divided in a vertical plane and prevent unsightly cracks.

In the case of arches under high fills and on ordinary soils it is difficult to prevent cracking of the arch abutment and ring unless reinforcement is used, on account of the pressure on the foundation in the center of the arch being very great when compared with the pressure at the end of the wing walls. The monolithic character of the arch abutment and the arch ring are not strong enough to distribute the load uniformly over the foundation, and when a slight settlement occurs in the center it causes cracks that are unsightly but seldom dangerous.

Cause 3.—Several railroads reported temperature cracks in their abutments, while other roads reported abutments built of plain concrete in lengths of from 60 to 100 ft. without cracking, and when the abutment was reinforced in lengths of 150 ft. without cracking. There is evidently a wide difference of opinion as to the effect of changes of temperature on large monolithic structures. The front of the abutment has no forces to prevent its free contraction and expansion on the back, side and bottom of the abutment; however, the concrete contracts and expands more than the material adjoining it and hence when the movement occurs the structure must be strong enough to overcome the friction between it and the adjoining material, or crack.

Causes 5 and 7.—A monolithic structure well designed will resist failure from both of the causes better than an abutment built in sections.

Cause 6.—In designing waterway openings the size of the opening is selected to take care of the maximum amount of water that is likely to come to the opening. It frequently happens that the amount of water has been underestimated or that the opening has been blocked by driftwood, ice gorges or other material which has induced scour in the bed of the stream or raised the high-water mark, or both. When the scour line is below the foundation of the abutments they are apt to move and tip forward or settle bodily downward. When this happens a monolithic abutment will resist the pressure back of it better than one built in sections, because when one portion of the abutment is undermined the balance of the abutment will assist in preventing failure, and, even if the abutment does tip forward, the movement at times is slow, and failure can be prevented by relieving the pressure at the back or putting in props across the bridge opening.

In building abutments for subways it is frequently impracticable to build them as a single monolith, and, even if it were practicable, the abutment when underneath a number of tracks would be long, not very high and any slight settlement would cause an unsightly crack. The abutment would be in a prominent place, where any crack would be observed by the general public and create unfavorable comment.

Again, when abutments are built in horizontal layers and the work is not done continuously, wherever the work has been stopped long enough to allow the lower portion to set before placing the upper portion a seam has been found in the concrete, and when the back filling has been made and become saturated with water the water will pass through the concrete through this seam. In city work this seepage is unsightly, it will form ice on the sidewalks in the wintertime and the action of the frost will disintegrate the concrete. For these reasons it is desirable that when abutments are built in sections they be built of such length that each section can be built continuously.

Conclusions: These conclusions are based upon the supposition that the structure is well designed and that the foundation is good:

(1) That monolithic concrete construction may be used without danger of cracking for abutments of any length that the working conditions will permit, provided the length does not exceed about three times the height.

(2) That where abutments with wing walls are not of mono-

lithic construction, joints should be provided at the intersections of the wing walls and the body of the abutments.

(3) That reinforced concrete abutments may be built in units of any length that economic conditions will permit.

(4) That monolithic concrete construction may be used for arches where the conditions will permit, otherwise the arch ring should be constructed with radial joints.

Retaining Walls and Abutments.

The committee reports progress and suggests that the work be reassigned.

Reinforced Concrete Trestles.

Through the secretary, a circular letter was sent out on October 26 to a large number of railroads, asking for the extent of the use of reinforced concrete trestles, the length of time they had been in service, their present condition and apparent durability and the approximate cost for ordinary conditions. Forty-six replies to this letter have been received. The C., M. & St. P.; C., B. & Q.; C., R. I. & P. and N. P. railways have built such trestles, while the G. N. and C. G. W. railways have made plans for similar structures. The other replies state that the roads have not used this type of construction, though a number of them use decks of reinforced concrete and structures built in place.

In view of the limited time this form of structure has been in use, it does not seem best to present typical plans for reinforced concrete trestles at this time.

The report is signed by: W. H. Petersen (C., R. I. & P)., chairman; G. H. Tinker (N. Y. C. & St. L.), vice-chairman; W. J. Backes (Cent. N. E.); G. J. Bell (A., T. & S. F.); C. W. Boynton (Univ. Port. Cem. Co.); W. W. Colpitts (K. C., M. & O.); T. L. Condron, consulting engineer, Chicago; B. Douglas (Detroit River Tunnel Co.); L. N. Edwards (Grand Trunk); A. H. Griffith (B. & O.); Richard L. Humphrey, consulting engineer, Philadelphia; Howard G. Kelley (Grand Trunk); R. T. McMaster (P. & L. E.); C. H. Moore (Erie); F. E. Schall (L. V.); G. H. Scribner, contracting engineer, Chicago; A. N. Talbot, professor municipal and sanitary engineering University of Illinois; F. L. Thompson (Ill. Cent.); Job Tuthill (C., H. & D.).

Discussion on Masonry.

The recommendations for revision of the manual were accepted with very little discussion.

The definitions of monolithic construction, and the conclusions of the committee for publication in the Manual were accepted.

Mr. Steffens: In the matter headed, "Investigate and report on the use of reinforced concrete trestles, typical designs and cost," there is mentioned particularly the flat slab trestle construction, which has been used so extensively by the roads in Chicago. The Southern railway has built another type of flat slab trestle in North Carolina, a trestle of girder construction, of reinforced concrete, and it might be well for the committee to see if plans can not be obtained and a note made in the proceedings.

Mr. Loweth: We have been building something that is closely akin to a concrete trestle for a good many years, in the form of reinforced culvert tops. The concrete trestle in one way is a larger development of the reinforced concrete culvert tops. We have gone into it quite extensively and so far as our experience goes it will warrant a more extensive use. We find that the cost, speaking generally, is about thirty dollars a foot, sometimes a little less and sometimes a little more, depending on the question of the amount of the work and the difficulties under which it is prosecuted. Sometimes we are able to build the slabs under traffic, but that is not often the case—more usually they have to be made on one side and moved in, or built some distance from the bridge and taken to the bridge and put in. We feel that in many cases there is a field of usefulness for the concrete trestle and that it gives a permanent construction at a cost much less than steel construction. We have in many cases steel spans of greater or less length crossing the main channel, and the approaches to the spans over flats that are subject to overflow only are of concrete trestle type construction. We have used spans up to eighteen feet; the standard being about 15 ft. 6 in. or 16 ft. We have to be careful to use them only in the places where we can use comparatively short spans. Lately there has been more or less apprehension concerning our timber bridges, due to fire caused by cinders dropping from the locomotives. When we get the new ash pan required by law and the concrete trestle we will get away from that danger. Of course, the same thing would be accomplished with a creosoted timber and ballasted floor and while we have used considerable of that type of construction, yet it does not afford the permanency we expect to get out of the concrete.

A. S. Baldwin: There is a suggestion I would like to make, arising from Mr. Loweth's remarks, with reference to the use of creosoted trestles; that is, in a comparison of the two methods of construction it is very important that the liability of the creosoted trestle to take fire should be considered. Our losses during the last year from fires in connection with creosoted trestles have been very heavy. We have had several thousand feet of these trestles burn.

The President: Open deck or ballasted floor.

Mr. Baldwin: Ballasted floor decks. In some cases we have not been able to trace the exact cause of those fires. Investigations show that as a general thing when you capitalize the cost of a creosoted structure, it does not compare favorably with the concrete structure. At the same time, I believe if reliable statistics could be obtained as to the amount of loss in creosoted structures by fire, that the results would be very different, and we are now endeavoring to get some actual data as to that.

Mr. Loweth: There is an illustration in the report of some of our designs for concrete trestles, but in the light of the experience we have had, we are going to make some modifications. They will be quite minor, but some modifications will be made. We shall probably put a metal plate between the slab and the top of the pier, so as to make a greater resistance in the top of the pier against any slight movement in the slab.

Mr. Smith: I have looked into the question of reinforced concrete trestles, and I have not found where we would be justified in adopting them. Our trestles cost us about $8.00 a running foot, our maintenance about 75 cents per foot, our fire losses about 5 cents per foot. The interest, at 5 per cent on $8.00 per foot, is 40 cents, making a total of $1.20 for the timber trestle. As against that, the reinforced concrete trestle cost $30 per foot, would have an interest charge of $1.50, to which we would add 20 cents per foot for track maintenances, which would be $1.70, or approximately a difference of 50 cents per foot increased cost for the concrete trestle. We have about 155 miles of timber trestles, or 800,000 lineal feet. Of that number, 300,000 feet will ultimately be disposed of, either by filling or by replacement by steel structures. The other 500,000 feet at 50 cents per foot, would increase the cost to the railroad company, $250,000 per year, if we were to adopt reinforced concrete trestles.

W. L. Seddon (Seaboard A. L.): I would like to ask whether there has been any other experience of fire losses as suggested by Mr. Baldwin. We have not used creosoted trestles long enough to get any data on that, but I hadn't expected a very great amount of loss from creosoted trestles. Creosoted telephone poles went through the fire at Jacksonville, Fla., and were the only things of wood that stood that fire.

Mr. Baldwin: Our experience shows that there is less danger of a creosoted piece of timber catching fire than of a piece of old defective timber. A spark on a piece of defective timber will start fire very rapidly, whereas if it comes against a sound piece of creosoted timber, it does not light, and does not take fire rapidly; but after the fire starts in those structures, it is so fierce as to be almost uncontrollable. That is the case with creosoted ties that have been placed along the right of way. I do not think they catch as readily at old timbers, but after they start, you cannot do anything with them, the fire is so fierce and the heat so intense, it is impossible to control the fire.

Mr. Seddon: Has your loss been from fires originating on the right of way?

Mr. Baldwin: In one case the loss was from an adjoining structure. In several other cases we have not been able to find out what was the cause of it.

Mr. Seddon: I examined the poles at Jacksonville after the fire there and they seemed to be charred about an eighth of an inch, and then the fire seemed to have choked itself.

The President: I think there is a general theory that after the lighted oil evaporates from the surface the chance of creosoted material catching fire is remote.

Mr. Smith: We have kept a good record of our fire losses for about two years and we have found that about 95 per cent of the fires start on top. A good many start from cinders that drop down. A good many of them could be averted by covering the deck with galvanized sheet iron. I understand some roads have used galvanized sheet iron on top of the stringers, which would prevent the stringers catching fire. By placing galvanized iron on top of the ties, at the end of the bridge, over the back walls, the fires would be eliminated.

Mr. Loweth: Last year the St. Paul company fireproofed the timber decks of about ten miles of bridges, and we shall probably do as much more this year. That is an added expense, not only for the cost of first construction of the fireproofing, but because it makes the future maintenance of the bridge and the inspection of the bridge more expensive. However, it is forced upon us because there seems to be an increasing danger of fire to timber bridge floors on account of the changes in the locomotive fireboxes which have recently been brought about. All of the timber bridge floors on the coast extension of the St. Paul road are fireproofed from one end to the other, and I feel that we will eventually have to come to protection of that kind on practically all of our timber floors; perhaps not for timber floors on steel structures, but certainly for those on timber stringers. Our practice has been to carry the metal protection clear across the full length of the bridge, and at first I tried to eliminate it between the rails, but found that that did not give the full measure of safety, and it was necessary to carry the protection out to and over the outer guard timber. In a great many cases we have put in gravel protection. We are trying out both methods. The gravel protection consists in putting in board strips between the tops, blocking them up above the stringers, and then putting gravel on top of the ties and the board strips. It takes, however, a pretty coarse gravel. In some cases we could not get the gravel that was suitable and we used crushed stone. There is some difficulty, of course, in maintaining the gravel, because the tendency is for it to work to one side or the other. I believe if we compare the cost of an ordinary timber structure with any other prominent type of construction that we must take into consideration the cost of fireproofing timber structures. We have not been able to justify on the score of economy alone the large use which we have made of reinforced concrete trestles, or even creosoted ballast trestles; but I think that we must concede something for better construction, even if it is not economy.

Mr. Smith: We have recently been offered by the mechanical department a lot of scrapped car roofing, which we figure can be applied to our old trestles at a cost of 10 cents per running foot, which is practically no increase in cost. The stringers in our trestles last us eight to twelve years; in the south a relatively shorter period, perhaps eight years.

Mr. McDonald: We have been using galvanized iron as protection for stringers and caps for ten years. We have had a great deal of difficulty in keeping galvanized iron on the stringers. It has a tendency to creep. The cause of creeping we have been unable to determine absolutely, but we have discovered measures that we can depend upon. I have discovered that pine stringers, which have been well covered for ten years, have been in good condition, as good as they were when put in. Our fire losses last year on trestle work, out of a total of 7 miles, amounted to 24 lineal feet. Those trestles are all decked. My attention was first called to the question of protecting stringers with galvanized iron by noticing the experience of the Cincinnati Southern. They had a lot of stringers that were put in in 1871. I had occasion to examine them after they were taken out, in 1889, and notwithstanding the fact that the galvanized iron had not been taken care of, had been permitted to be perforated, wherever that iron remained over the stringers, those stringers showed almost no rot whatever. They were made of white pine. I find that it costs us 80 cent a lineal foot of trestle to cover, in a very elaborate way, our stringers and caps. A red oak or gum cap can be made to last ten or fifteen years. Ordinary galvanized iron, bought in the open market, when applied to trestle work, will last on some branch lines five or six years, and on the main line, where sand is dropped from the locomotive, it lasts only about three years. Recent experiments have justified us in the adoption of the mod-

ern pure iron, as it is called, and we think we are going to get at least an average of seven years life out of that metal, and I expect to fully realize twenty years life out of the timber by that method of protection.

THURSDAY, MARCH 23.

The Thursday morning session of the American Railway Engineering and Maintenance of Way Association was called to order at 9:30 o'clock by President Fritch.

SIGNS, FENCES AND CROSSINGS.

The following subjects were assigned:
(1) Consider revision of Manual.
(2) Report on ways and means for securing a proper quality of fence wire to resist corrosion and secure durability.
(3) Continue investigation of the use of concrete fence posts and submit recommendation.
(4) Continue invesitgation as to the best form of track construction and flangeways in street crossings and paved streets.

Revision of Manual.

No changes are recommended further than those submitted in the report for 1909, which the committee recommends to be adopted and included in the manual.

Proper Quality of Fence Wire.

The committee has been energetic in pursuing its investigations, scrutinizing and testing out every new theory advanced pertaining to the preservation of wire and proving its merits or demerits. Thus far, however, no new process has been discovered which offers any advantage over the old, and it is the opinion of the committee that applied galvanized coating, by special treatment, is the best and only known economical process for protecting wire used in railway fences against corrosion.

Conclusion: The committee recommends the use of wire which has received a special galvanized coating to stand a test of four one-minute immersions in the standard copper sulphate solution, the galvanizing to be done preferably after weaving.

Concrete Fence Posts.

The tests, observations and use of concrete fence posts during the current year indicate:
(1) That concrete fence posts are practicable, durable and economical.
(2) The eight-foot post is recommended.
(3) Posts of cross-section approaching a square form are easiest made and most suitable for fencing.
(4) Spacing, same as recommended for wood posts.
(5) Stone or gravel used in mixing concrete for fence posts should pass a half-inch square mesh. Concrete should be mixed wet, in a batch mixer, and poured into the moulds. The poured posts are a little over 25 per cent stronger than tamped posts of the same size, mixture and reinforcement; they are also better able to withstand the action of frost and alkali. Experience shows that extra precaution should be used in the selection of material, mixing of concrete and handling and curing the posts. For the best results, posts should be allowed to remain in the yard undisturbed for at least sixty days after coming from the moulds.
(6) Breakage in handling and transportation should not exceed three-tenths of one per cent.

Conclusion: Concrete fence posts are recommended for railway fences.

Flangeways in Street Crossings.

On this subject the committee reports progress. The sub-committee having it in hand have worked hard to formulate plans and make recommendations, but the subject is of so much importance, the committee feel that more time should be given for their investigation.

The report is signed by: W. D. Williams (Cin. Nor.), chairman; K. J. C. Zinck (Gr. Tr. Pac.), vice-chairman; A. M. Funk (B. & O.), W. H. Hoyt (D. M. & N.), E. R. Lewis (Mich. Cent.), Joseph Mullen (C. C. C. & St. L.), W. J. Burton (Mo. Pac.), C. H. Stein (Cent. of N. J.), E. J. Steinbeck (Ill. Cent.).

Discussion on Signs, Fences and Crossings.

Mr. Zinck: The committee asks that the association refer this report back to them for further work during the coming year. I make a motion to that effect.

The President: You will note that the committee has made certain recommendations, but without further consideration, they think it is proper to refer the matter back to the commitee in order that they may make a more complete report next year.

The motion was carried.

WATER SERVICE.

The following sub-committees were appointed:
Revision of the Manual: Robert Ferriday, A. D. Schermerhorn.
Water tank specifications: J. L. Campbell, G. H. Herrold, W. A. Parker, C. A. Morse.
Water stations for track pans: E. G. Lane, L. P. Rossiter, H. M. Church, James Burke, A. Mordecai.
Recommendations for next year's work: C. L. Ransom, Robert Ferriday, J. L. Campbell, E. G. Lane.

Water Tank Specifications.

The reinforced concrete tank was considered as rather a new departure, and the following specifications and design are submitted as a progress report only:

Specifications for a Reinforced Concrete Water Tank.

1. The tank shall be of reinforced concrete, as shown on the drawings.

2. The capacity of the tank shall be within the limits of 50,000 and 106,000 gallons, exclusive of the lower 20 ft. of the tank. The height of the tank from bottom to top of shell shall be 40 ft. A diameter of 30 ft. is recommended. On this basis the drawings have been made. The latter shall be made to meet the requirements of the height and diameter selected by the engineer.

3. The tank is designed to deliver water to locomotives through water columns. The floor of the tank shall not be lower than the tracks served.

4. In earth, the excavations for the foundation and pipes shall be as deep as the lowest frost line, with a minimum depth of 4 ft. In rock, only the trenches for the pipes shall be carried below the action of frost. In earth, the bottom of excavations shall be thoroughly tamped to discover and compact any soft places. If the earth will not sustain the total load, including wind pressure, without material or unequal settlement, the foundation shall be supported on piles of the number, size and arrangement as determined by the engineer. Such piles shall conform to the specifications of this association for piling, as selected by the engineer.

5. The foundation shall consist of a disk of concrete, as shown. If the depth of frost is excessive, this disk may be carried on broken rock compacted in the bottom of the excavation, but the minimum vertical thickness of the concrete foundation, exclusive of the tank floor, shall be 42 in.

6. The valve box for the piping shall be constructed as a part of the foundation, as shown. The top and bottom of the box shall be reinforced by steel rods laid both ways and doubled around the pipes and the manhole. The manhole frame shall be in one piece of first-class cast-iron with a double seat and a double cover. The latter shall preferably be of wood. When low temperatures require it, an air space shall be constructed in the middle of that portion of the box walls outside of the tank foundation, to prevent freezing within the valve box. When the absence of low temperatures permit, the air space and the lower manhole cover may be omitted.

7. The reinforced concrete floor on the foundation shall be constructed, as shown, giving its surface a sidewalk finish without plastering.

8. The reinforced concrete shell shall be constructed, as shown, building in the concrete fillet in the angle at the bottom.

9. The reinforced concrete roof, including manhole and cover, shall be constructed, as shown, finishing top of roof as specified for the floor. Where ice will not form to an injurious or troublesome extent and sunlight will not cause vegetable growth in the water, this roof may be omitted at the discretion of the engineer.

10. The tank shall be equipped with cast-iron piping and standard gate valves, as shown. There shall be a tank supply pipe, a water column supply pipe, an overflow pipe and a washout pipe, the latter two being combined in the valve box beyond the valve closing the washout pipe. There shall be no valve in the overflow pipe. For a gravity supply, the tank supply pipe shall be carried to the top of the tank and be capped by a float valve. The washout pipe shall terminate flush with the tank bottom. The water column pipe shall extend several feet above the bottom but not higher than the top of the water column. All piping shall pass through the bottom of the tank, preferably in cast-iron stuffing boxes with lead joints, as shown, but other forms of stuffing box and joint may be used.

All pipes and castings, in quality, manufacture and inspection, shall fulfill the requirements of the specifications of the New England Water Works Association for cast-iron pipe.

The weights and diameters of the pipes shall be determined by the engineer. No pipe shall have an inside diameter less than 4 in.

11. The cast-iron sludge pipe shall be carefully constructed, enclosing in the concrete and doubling the reinforcing rods around it, as shown. When absence of sediment in the water justifies, this pipe may be omitted.

12. The tank shall be equipped with a gage, indicator and float, according to the design or selection of the engineer.

13. The steel ladder shall be constructed, as shown and as designed, or selected by the engineer. The ladder shall be carried by connecting straps or angles resting on the roof. It shall not be anchored to the tank shell. The steel shall conform to the specifications of this association for steel bridges.

14. The concrete in the tank foundation and the side walls of the valve box shall be a 1-3-5 mix, made and laid in accordance with the specifications of this association for Portland cement concrete.

15. The top and the bottom of the valve box and the tank floor, shell and roof shall be made of reinforced concrete.

16. Reinforced concrete shall be a thoroughly uniform mixture of cement, sand, stone and water completely enveloping the reinforcing rods.

17. The volume of the stand shall be 5 per cent in excess of the volume of the voids in the stone. The volume of the cement, considering 100 lbs. of it as 1 cu. ft., shall be 25 per cent in excess of the volume of the voids in the mixed sand and stone. The engineer shall determine the voids and proportions.

18. The volume of the water shall be sufficient to give the concrete a fluidity that will cause it to flow and mould itself in the forms without tamping.

19. The concrete shall preferably be mixed by mixing machines. The method used shall yield a complete and even mixture.

20. All dirt and foreign matter shall be excluded from all materials, concrete and stages of the work.

21. The concrete, after mixing, shall be poured and worked into final position in the forms before its initial set is complete, and it shall not thereafter be disturbed. As it is thus placed, it shall be thoroughly worked by long, flat, thin-bladed tools in a manner that will eliminate all voids and air pockets and produce unbroken mortar faces against all forms and secure perfect contact with every part of all reinforcing rods.

22. The surface of concrete shall be clean and wet when concrete is laid thereon. The surface, if hardened, shall also be mopped with cement grout immediately in advance of placing fresh concrete. Smooth or finished mortar surfaces shall be avoided where additional concrete is to be placed. If necessary, as in the joints between the tank floor, shell and fillet, old surfaces shall be tooled, cleaned and grouted before concrete is placed thereon.

23. A rapid drying out of concrete shall be prevented by regular, frequent and continued wetting until all danger of arrested setting and hardening is past, as the engineer shall direct.

24. Freezing of concrete before it has finally set shall be prevented.

25. Any concrete broken or displaced in any manner after having set shall be removed from the work.

26. The cement shall conform to the specifications of this association for Portland cement. It shall retain its original purity and qualities until it is incorporated into the work. Deteriorated or otherwise damaged cement shall not be used.

27. The sand shall be clean, sound and sharp and it shall be of graded sized grains giving a minimum of voids.

28. The stone shall be clean, sound and durable. The word "stone" includes broken rock and gravel. The stone shall be of graded sizes giving a minimum of voids. All of it shall be able to pass through a circular hole having a diameter of ¾ in.

29. The water shall be clean and free from anything injurious to the concrete.

30. The concrete forms shall be made of metal or of dressed and matched lumber. They shall be accurately made and erected, be water tight, and shall have ample strength and rigidity to prevent bending and warping under the load and action of the concrete. They shall be erected in such sections and courses as will permit the concrete to be poured and worked as above specified. No device for holding the forms that would leave a hole through the concrete shall be used. Wires passing through the concrete shall be nipped off beneath the concrete face.

31. Any break in the concrete surfaces not impairing the integrity of the structure shall be pointed with cement mortar, as the engineer shall direct. Any other imperfections in the concrete shall be treated and remedied as the engineer shall direct.

32. The concrete shall be reinforced by steel rods of the form, size, number and arrangement, as shown. They shall be wired at intersections with each other and be maintained in required position as they are buried in the concrete, at which time they shall be free from dirt and scale. Splices in rods shall be lapped 42 diameters or sides. No splice shall be opposite a splice in an adjacent line of rods. Throughout the splice the ends of the rods making it shall be 1½ diameters or sides apart in the clear. There shall be not more than four splices in the circumference of a tank 30 ft. in diameter. Unnecessary splicing shall be avoided.

33. The reinforcing rods shall be plain or deformed. Their tensile strength per sq. in. shall be between 60,000 and 90,000 lbs. Their elastic limit shall be not less than one-half of their tensile strength. They shall not be stressed more than one-third of their elastic limit. Any rod shall be capable of being bent cold on a radius of three diameters or sides through 180 degrees without sign of fracture.

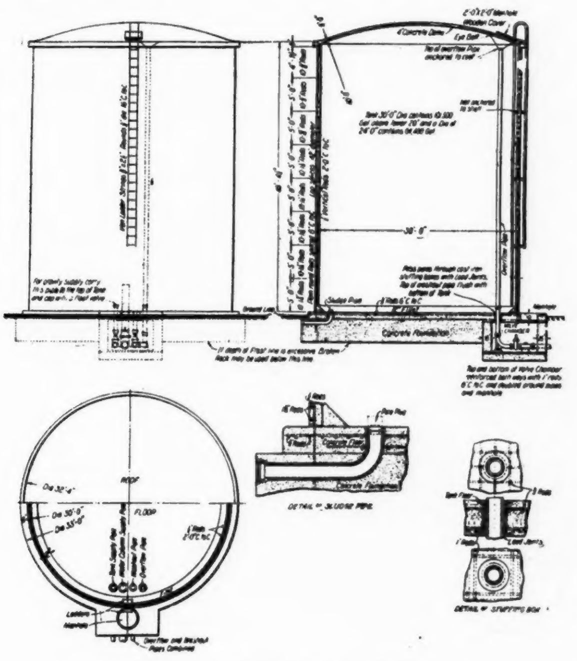
34. A dense, even mixure of concrete as herein specified for reinforced concrete shall be the primary expedient to secure watertight concrete. This may be supplemented by mixing with the cement some form of waterproofing compound of proved efficiency and now obtainable from manufacturers.

Where the concrete can be worked before it has set, the surface shall be thoroughly troweled until a dense mortar face is secured. Concrete surfaces already set may be plastered by rich cement mortar, but surfaces so treated shall first be cleaned and roughened by steel brushes or equivalent, and the plastering shall be applied on a fresh coat of cement grout mopped on the surface.

In addition, if necessary, separate and alternate washes of soap and alum in the order named shall be applied to the dried and hardened concrete surface. The number of washes should be not less than two of each, with a 24-hour interval between each. The proportion should be approximately ¾ lb. of soap and ⅛ lb. of alum per gallon of water. These proportions may be varied if better results are thereby secured. The soap wash shall be applied boiling hot, without causing frothing. The alum wash should have a temperature between 60 and 80 degrees Fahrenheit.

In lieu of these washes approximately 1 per cent, by weight of powdered alum may be evenly mixed with the cement, in which case the same proportion of soap shall be dissolved in the water in making the concrete.

In lieu of soap and alum, waterproofing paint having an asphalt base to be applied hot or cold, and now obtainable from manufacturers, may be used. In all washing or painting the concrete surface treated shall be dry and clean and the temperature should be above the freezing point.



Reinforced Concrete Water Tank.

35. The weight of water shall be assumed to be 63 lbs. per cu. ft. Wind pressure, acting in any direction, shall be assumed to be, in pounds, thirty times the product of the height by two-thirds of the diameter of the tank, in feet.

Specifications for Wooden Water Tank.

1. The tank shall be a wooden tub carried on timber posts supported on concrete piers, as shown on the drawings. These specifications provide for an all-wood structure above the foundation, as shown.

2. A diameter of 24 ft. and a height of 16 ft. (outside measurement) are recommended for the tub of this tank. Other dimensions may be used, but the design shall conform to the requirements of these specifications.

3. The tank is designed to deliver water to locomotives through water columns. The bottom of the tub shall be not less than 20 ft. above the tracks served.

If water columns are not used, the location of the tank and the necessary tank fixtures shall be selected by the company.

4. Water shall be assumed to weigh 63 lbs. per cu. ft. Wind pressure in pounds acting in any direction on the tub shall be assumed to be thirty times the product of the height by two-thirds of the diameter of the tub. The wind pressure on the substructure shall be assumed at 30 lbs. per sq. ft. of its surface acted on.

5. Necessary anchorage shall be provided to the foundation on the basis of an empty tub, as the engineer shall design and require.

6. In earth, the excavation for the piers and frost pit shall be deep enough to permit the pipes to be laid below the frost line, with a minimum depth of 4 ft. In rock, only the excavations for the frost pit and the pipe trenches shall be carried below the action of frost.

On earth, the total load including wind stress shall not exceed the safe load for that earth. If the earth will not carry this load without material settlement, piling shall be put in as the engineer shall direct. Such piling shall conform to the specifications of this association for piling, as selected by the engineer. Earth foundations shall be thoroughly tamped to detect and compact any soft places therein.

7. The piers and frost pit shall be of concrete of a 1-3-5 mix, made and laid according to the specifications of this association for Portland cement concrete and to the forms and dimensions, as shown, including the proper setting of all anchor bolts.

8. The substructure shall be constructed as shown. The timber shall be pine, oak, cypress or redwood, S 4 S for painting, and conforming to the specifications of this association for No. 1 R. R. bridge timber. It shall be accurately framed and erected, properly tightening all bolts and tie rods.

9. All rods and bolts shall be iron or steel of the quality hereinafter specified for tank hoops. O. G. washers shall be used under heads and nuts of bolts and tie rods.

10. The tub shall be made of pine, cypress or redwood, sound, seasoned, out of wind, free from shakes, sap, pitch pockets or streaks, unsound knots, loose knots, knots in clusterrs, and large knots extending through the material. Small, loose or unsound knots may be bored out if the holes are thoroughly plugged. Material having knots in its edges will not be accepted.

11. The bottom of the tub shall be made of 3-in. planks, S 4 S, and accurately cut and planed to uniform thickness and width. The ends shall be cut to the true circle of and shall fill the croze in the staves. Each plank shall be in one piece without joint or splice. The planks shall be joined by ¾-in. wood dowels on 30-in. centers along each joint. The bottom shall be laid directly on the floor joists.

12. The staves shall be of uniform width, end to end, and shall be made of 3-in. planks, S 4 S, with edges accurately planed on radial lines from center of tub. Each stave shall be in one piece, without joints or splice. The croze in each stave shall be accurately cut to uniform dimensions on one circle for all staves. The croze shall be 3 in. in the clear from the end of the stave.

13. The tub hoops shall be half oval, half round, or round. They shall preferably be made of wrought-iron. They may be made of steel.

Wrought-iron shall be made of pure puddled iron having a tensile strength of 50,000 lbs. and containing of

Sulphur	not more than	.02 per cent.
Phosphorus	" " "	.005 "
Carbon	" " "	.02 "
Manganese	" " "	.00 "
Silicon	" " "	.00 "

Steel shall conform in physical and chemical properties to the specifications of this association for steel bridges.

Each hoop shall be in three equal sections.

14. Each hoop shall be cleaned (preferably at the factory) of dirt, rust and scale, and in that condition shall be heated to 300 degrees Fahrenheit and be dipped in pure asphalt having that temperature which shall be maintained during the immersion which shall continue not less than one minute.

15. Hoops shall have round threaded ends passing through lugs. The joint used shall be as designed or selected by the engineer. It shall be as strong as the hoop.

16. Hoops shall be of one size with the spacing varied, limiting the maximum space to 24 in. c. to c. of hoops.

17. Hoops shall be so spaced that, for wrought-iron, the stress per sq. in. on net section shall not exceed 10,000 lbs., and for steel 12,000 lbs. Threaded hoops shall preferably have upset ends, but a larger hoop giving the required area under thread without upsetting may be used.

18. The roof shall preferably be built in the form of a flat dome, as shown, but other forms may be used.

19. Each joist of the dome form shall preferably be in one piece of full-sized 2-in. lumber, but the longer joists may be built up to an equivalent section. The top of each joist shall be cut to a template having a radius of 84.5 ft., each end of the joist having a depth of 4 in. The length of each joist is determined by its position within the circle having a diameter of 25 ft. 6 in. and cutting the ends of the joists, as shown.

20. On the roof joists, 1-in. by 6-in. sheathing shall be laid solid and shall be cut to a circle having a diameter of 26 ft., as shown.

21. The roof eave shall be finished by 1-in. lumber and quarter rounds built on the ends of the joists, as shown.

22. The sheathing shall be covered by metal, bituminous felt or burlap roofing, tar and gravel, asphalt, mastic, or other prepared waterproof roofing, limiting the selection to brands of proved effi-

ciency. If other than the dome form of roofing is used, shingles or barn boards may be used.

23. The manhole in the roof shall be constructed as shown.

24. When required for frostproofing the roof shall be sealed, as shown. Where ice will not form to an injurious or troublesome degree and sunlight will not cause vegetable growth in the water, the entire roof and ceiling may be omitted.

25. The frost shaft, extending from the frost pit to the bottom of the tub, shall be constructed, as shown, enclosing it by multiple walls of 1-in. by 6-in. lumber, S 1 S and 2 E, separated by 2-in. by 4-in. studding on edge or side. Each wall shall have two courses of lumber separated by a layer of heavy tar felt. The outside course shall be tongued and grooved. The number of walls shall be sufficient to prevent water in the enclosed pipe from freezing. A frostproof door in one side of the shaft shall be constructed as designed by the engineer.

When ice will not form, the entire frostproofing, including pit, may be omitted.

26. All lumber in the roof and frostproofing shall be No. 1 common, as rated by the Lumbermen's Association for the district supplying the material.

27. The tank shall be equipped with a tank supply pipe, a water-column supply pipe and an overflow pipe, as shown. The first two shall be provided with gate valves. For a gravity supply the tank supply pipe shall be carried to the top of the tank and capped by a float valve. The sizes of the pipe shall be determined by the engineer. No pipe shall have an inside diameter less than 4 in. All pipes shall pass through the bottom of the tank by two standard flanges full bolted with gaskets. For a pressure gravity supply, a stuffing box in lieu of flanges for the tank supply pipe may be used if necessary to prevent leakage. All pipes shall be enclosed in the frost shaft and pit and leave the latter below the frost line.

28. In the bottom of the tank outside of the frost shaft a sludge hole with plug shall be constructed as designed or selected by the engineer.

29. When the tank is finished, the hoops properly tightened and the wood saturated, the tub shall be water tight. No foreign material shall be used in making the joints in the tub.

30. The tank shall be equipped with a gage, indicator and float as designed or selected by the engineer. The clearance between the gage board and the tub shall not be less than 1 in.

31. The ladders shall be constructed, as shown, and as designed, or selected by the engineer.

32. All exposed woodwork shall be painted with one priming and two finishing coats, using the company's standard paint and colors for such work. All wood to be painted shall be dressed.

Specifications for an Iron or Steel Water Tank.

1. The tank shall be of iron or steel on a foundation, as shown on the drawings.

2. The capacity of the tank should be within the limits of 50,000 and 100,000 gallons, exclusive of the lower 20 ft. of the tank. The height of the tank from bottom to top of shell should be within 12 in. of 40 ft. A diameter of 30 ft. is recommended. On this basis the drawings have been made. The latter shall be made to meet the requirements of the height and diameter selected by the engineer.

3. The tank is designed to deliver water to locomotives through water columns. The floor of the tank shall not be lower than the tracks served. If water columns are not used, the location of the tank and the necessary tank fixtures shall be such as shall be selected by the company.

4. See specification No. 4 for reinforced concrete tank.

5. The foundation shall consist of a ring of concrete under the shell of the tank enclosing a broken rock foundation, as shown. Under the broken rock the earth shall be excavated, back filled and tamped to such depth and in such manner as may be necessary to secure proper support.

6. See specification No. 6 for reinforced concrete tank.

7. When wind pressure requires, the tank shall be anchored to the foundation by anchor bolts and lugs, as shown, and as designated or approved by the engineer.

8. The concrete in the foundation of the tank and the side walls of the valve box shall be a 1-3-5 mix, made and laid in accordance with the specifications of this association for Portland cement concrete. In the top and bottom of the valve box the concrete shall be a 1-2-4 mix, made and laid in accordance with the specifications of this association for reinforced Portland cement concrete. The extreme fiber stress on concrete shall not exceed 600 lbs., and in steel shall not exceed 12,000 lbs. per sq. in. as given by the straight line formula.

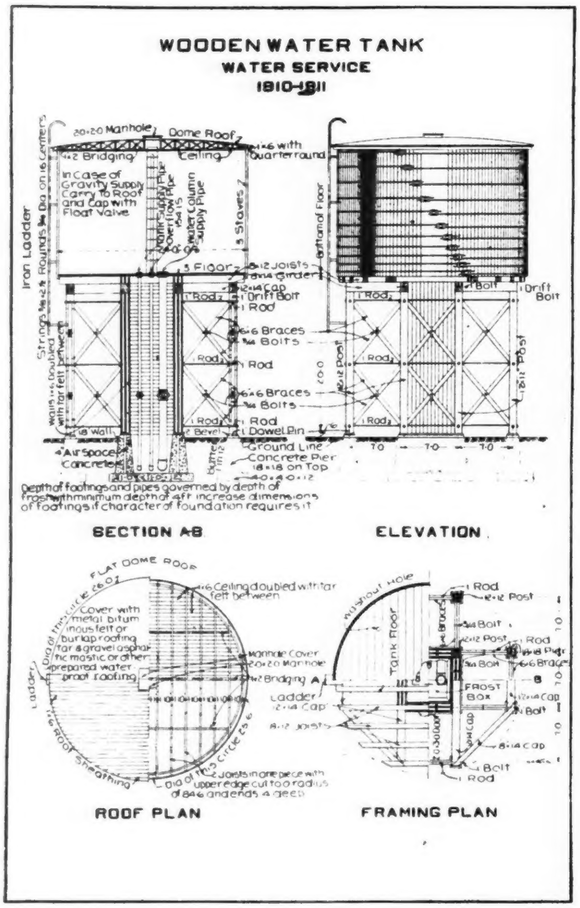
9. The rods and bolts shall be of steel and in quality they shall fulfill the requirements of these specifications for the steel in this tank.

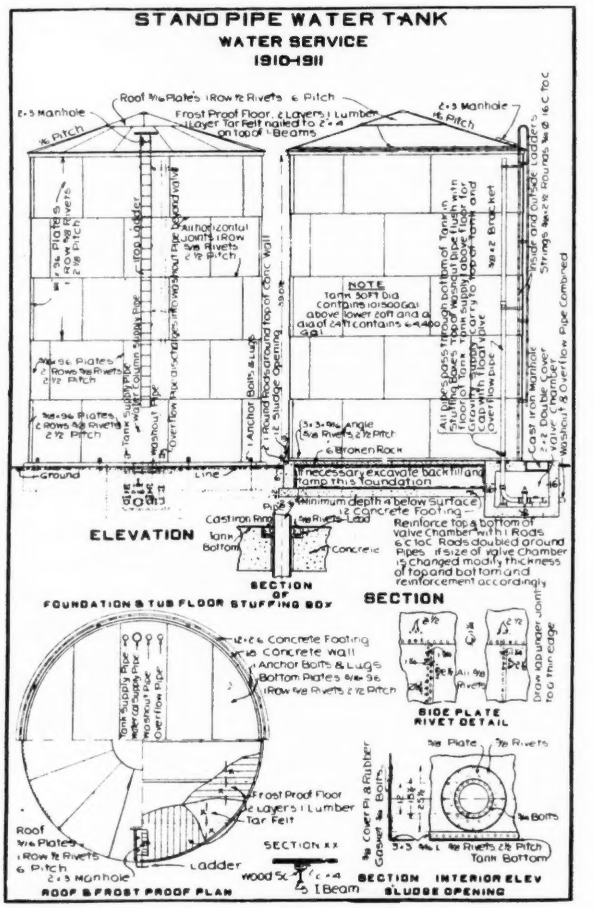
10. See specification No. 10 for reinforced concrete tank.

11. A sludge hole shall be constructed in the side of the tank at the bottom, as shown, and as designed or approved by the engineer. This opening shall preferably have a reinforcing ring and a cover plate, as shown, but other forms, including cast-iron, may be used.

If the absence of sediment in the water justifies, this opening may be omitted.

12. The tank roof shall be constructed of metal, including manhole, as shown. If necessary to prevent ice forming to an injurious or troublesome degree over the water in the tank, a ceiling shall be constructed under the roof of doubled 1-in. by 6-in. lumber, No. 1 common of the Lumbermen's Association for the district supplying the material, with a layer of heavy tar felt between. This ceiling shall be nailed to 2-in. by 4-in. nailing strips, bolted





to the top of I-beams carrying the ceiling. The latter shall be standard beams of proper weight and spacing for the span and load and shall be carried by the shell of the tank through standard connections.

Where ice will not form, as specified above, and sunlight will not cause vegetable growth in the water, the entire roof and ceiling may be omitted, in which event finish top of tank shell by a ⅜-in. by 3-in. by 3-in. angle.

13. The ladder shall be constructed, as shown, and as designed or selected by the engineer. The metal in this ladder, in quality and manufacture, shall fulfill the requirements of these specifications for the metal in the tank.

14. Metal Specifications.—The metal in these tanks shall be wrought-iron or open-hearth steel.

The iron shall be manufactured from pure puddled iron having a tensile strength of 50,000 lbs. per sq. in. This iron shall contain of

Phosphorus	" " " .005 "
Carbon	" " " .02 "
Manganese	" " " .00 "
Silicon	" " " .00 "
Sulphur	not more than .02 per cent.

The steel shall conform in physical and chemical properties to the specifications of this association for steel bridges.

The rivets shall be ⅝-in. in diameter.

15. The weight of water shall be assumed to be 63 lbs. Wind pressure, acting in any direction, shall be assumed to be, in pounds, thirty times the product of the height by two-thirds of the diameter of the tank in feet.

16. Unit stresses shall not exceed the following:

For Iron:
- (a) Tension in plates, 10,000 lbs. per sq. in. on net section.
- (b) Shear in plates, 8,500 lbs. per sq. in.
- (c) Shear on rivets, 10,000 lbs. per sq. in.
- (d) Bearing pressure on field rivets, 18,000 lbs. per sq. in.

For Steel:
- (a) Tension in plates, 12,000 lbs. per sq. in. on net section.
- (b) Shear in plates, 10,000 lbs. per sq. in.
- (c) Shear on rivets, 10,000 lbs. per sq. in.
- (d) Bearing pressure on field rivets, 18,000 lbs. per sq. in.

17. Plates forming the shell of the tank shall be cylindrical and of different diameters, in and out, from course to course.

18. All workmanship shall be first-class. All plates shall be beveled on all edges for caulking after being punched. The punching shall be from the surface to be in contact. The plates shall be formed cold to exact form after punching and beveling. All rivet holes shall be accurately spaced. Drift pins shall be used only for bringing the parts together. They shall not be driven with enough force to deform the metal about the holes. Power riveting and caulking should be used. A heavy yoke or pneumatic bucket shall be used for power-driven rivets. Riveting shall draw the joints to full and tight bearing.

19. The tank shall be made water tight by caulking only. No foreign substance shall be used in the joints. The caulking shall preferably be done on the inside of tank and joints only. No form of caulking tool or work that injures the abutting plate shall be used.

20. The minimum thickness of plates in the cylindrical part of tank shall be ¼-in. and in the bottoms $\frac{5}{16}$-in.

21. Lap joints shall be used for all horizontal joints and for vertical joints in plates not more than ⅜-in. thick. With thicker plates, double butt joints, with inside and outside straps, shall generally be used. The edge of the plate in contact at the intersection of horizontal and vertical lap joints shall be drawn out to a uniform taper and thin edge.

22. The diameter of rivet holes shall be $\frac{1}{16}$ in. larger than the diameter of the rivets used. The punching shall conform to the specifications of this association for such work on steel bridges. A close pitch, with due regard for thickness of plate and balanced stress between tension on plates and shear on rivets, is desirable for caulking.

23. The tank shall be equipped with a gage indicator and float, according to the design or selection of the engineer.

24. After being completely erected, caulked and cleaned of dirt, rust and scale, all exposed metal work shall be painted or treated with such coat or coats of paint or metal preservative as shall be selected by the railway company.

The report is signed by C. L. Ransom (C. & N. W.), chairman; Robert Ferriday (C. C. C. & St. L.), vice-chairman; James Burke (Erie); J. L. Campbell (E. P. & S. W.); H. M. Church (B. & O. S. W.); G. H. Herrold (C. G. W.); E. G. Lane (B. & O.); A. Mordecai, consulting engineer; C. A. Morse (A. T. & S. F.); W. A. Parker (St. Jos. & Gd. Is.); L. P. Rossiter, Hazelwood, Pa.; A. D. Schermerhorn (Un. Pac.).

Discussion on Water Service.

(The secretary then read Par. 2, 3, 4 and 5.)

J. L. Campbell (E. P. S. W.): I would suggest that it would be better if we would transpose the phrase in paragraph 5, making it read: "Necessary anchorage to the foundation shall be provided."

The President: If there is no objection, that will be done.

J. P. Snow (B. & M.): I object to having the concrete so definitely specified in paragraph 7. The foundations might be made of stone masonry and be made all right. It says, "the piers and frost pit shall be of concrete." I think that is a bad word to put in the manual in that connection.

The President: The committee will accept Mr. Snow's suggestion, and will change that to "masonry."

Mr. Stephens: I think that the comma after "small" in paragraph 10 should be eliminated, so that it would read, "small loose or unsound knots."

Mr. Campbell: It is the intention of these specifications to distinguish between small knots and loose knots.

H. A. Lloyd (Erie): It seems to me the specification for the kind of wood is a little too general. The family of pine is very large, and in using Norway pine you might get bad results.

Mr. Campbell: In the word "pine" the committee intended to include any word that would properly come under that general class of timber, which would include yellow pine, white pine, douglas fir, and possibly other classes of pine that would be entirely suitable.

G. D. Brooke (B. & O.): I hardly think it is the intention of the committee that a large loose knot should be bored out and the hole plugged.

W. H. Courtenay (L. & N.): It seems to me it would be better to omit the comma.

The President: The committee will accept that.

C. H. Stein (C. of N. J.): In reference to the first line of the paragraph, there should be something more specific in regard to the kind of pine. If we place a specification like this in the hands of the contractor, he might make a tank out of some species of pine which is objectionable, and I would like to ask, for information, whether any kind of cypress would be suitable for a water tank

Mr. Ranson: Quite a number of southern firms are making tanks out of cypress and many southern roads are using them.

Mr. Ranson: The committee would be glad to have suggestions as to changing this reading to make it plainer.

A. K. Shurtleff (C. R. I. & P.): My suggestion is that this be left blank, to be filled in by the company selecting the wood they desire the tank to be made of. The specification should be specific.

Mr. Campbell: This committee last year brought in a specification for tanks full of blanks, and the association wanted the blanks filled in. The idea in the preparation of these specifications was to cover the quality of the wood—to make it as general as the committee thought permissible, and then specify the quality. It is true that "pine" would admit any kind of pine, but the specification says it should be sound and seasoned. I believe it is the opinion of the committee that any sound and seasoned wood would be durable, provided it was kept saturated.

A. F. Robinson (Santa Fe): I would like to suggest that you make that first line read "the tub shall be made of suitable pine" or "the tub shall be made of acceptable pine."

The President: The committee will accept that.

Mr. Loweth: I should like cedar put in there for the staves and fir for the bottom.

The President: The committee will accept that.

Mr. Campbell: I suggest we add to the sentence in paragraph 11, in regard to the length of plank, these words, "for all tanks having a diameter not greater than 24 feet."

The President: The committee will accept that suggestion.

The chairman suggests that the word "each" be substituted for the word "the" in the first line of paragraph 12.

Walter Loring Webb: I notice that the stave shall be of uniform width end to end, etc. That practically limits these tubs to the cylindrical style rather than the conical. Is it the intention to cut out the use of conical tubs?

Mr. Ranson: Yes.

Mr. Webb: Is that not a distinct departure from common practice?

Mr. Ranson: It is a departure from common practice of twenty years ago, but not a departure from modern practice.

O. E. Selby (C. C. C. & St. L.): I see nothing in the specification to limit the width of the staves. The tendency of the manufacturers is to make the staves as wide as they consistently can, because it makes the job cheaper, and I suggest that the limiting width of ten inches be inserted.

Mr. Ranson: I think there is not much trouble to be anticipated on that score as it is difficult to get lumber of this quality that is wider than 8 inches.

Mr. Selby: We have found there is likely to be difficulty where the width is not limited, as the manufacturers will put in staves up to 10 and 11 inches wide, and they do not give satisfactory services. It is not hard to get timber of the quality demanded in fir and yellow pine, and in cypress, up to widths of 12 inches or more.

Mr. Robinson: There is an increased cost per thousand feet, board measure, for timber over 10 inches wide, and I do not think we need to worry about the manufacturers putting in many 12-inch planks, when they can use 10-inch, at $2 per thousand feet, board measure, less cost.

C. E. Lindsay (N. Y. C. & H. R.): While it may be true that the conical tub is a thing of the past, many railways are still using them, and as a conical tub has the merit of taking advantage of the force of gravity in keeping the hoops from falling off entirely in the event of shrinkage, I would like to endorse the conical tub.

W. M. Camp: The same question was up before the American Railway & Building Association last October, and the sentiment expressed in the discussion there seemed to conform to the committee's report, that cylindrical tubs are now preferable, since adjustable hoops have come into service. In former years, when solid hoops were used and had to be driven down, of course it das desirable to have the conical shape of tub.

(The secretary read Section 13. Tub Hoops.)

Mr. Brooke: I suggest that the last paragraph of Section 13, reading, "Each hoop shall be in three equal sections," be combined with the first paragraph, which would then read: "The tub hoops shall be half-oval, half-round, or round, and shall be in three equal sections."

Mr. Campbell: There has been some question raised as to the advisability of having three joints in the hoop. I suggest we change it to read: "Each hoop shall be in not more than three sections," and we will accept the suggestion and change the reading.

Mr. Courtenay: If this association is to go on record as abandoning the flat hoop, I think it would be desirable to go the whole length, to the round hoop. I am not able to see the advantage of a half oval or half round hoop as against a round hoop. The round has the simplest form of the three, it is generally easier to get, and I am unable to see any advantage which the half round has over the round. I think to some extent the half round would offer some of the disadvantages of the flat hoop; that is, it would rust speedily on the flat side in contact with the tub. That has been the overwhelming objection to the flat hoop. I have known of many cases of failures of the flat hoop, where the outside of the hoop appeared to be sound. If we are to change to some form of approximately round, it seems to me it would be better to adopt the round and leave out the half oval and half round.

Mr. Campbell: There is the objection to making one specifica-

tion for round hoop that shall limit the recommendation to one thing. The committee believes the half oval or half round hoop is a decided improvement over the flat hoop, on account of the greater concentration of the metal and smaller surface exposed to corrosion, and in the preparation of the specifications the committee endeavored to avoid mentioning any one specific article, where we could avoid doing so, particularly where other equally good forms could be included.

Mr. Snow: I seriously object to limiting this to a round hoop on account of the trouble arising from dust and dirt collecting above the round hoop, and moisture on the outside of the stave. It might be supposed that you could keep the hoop filled with paint, but the hoop will drop away from the paint and you will have a groove there and it will rot the stave.

Mr. Lindsay: Is there anything about the round hoop or oval hoop that requires three adjusting points? We have been able to maintain tanks successfully and economically with one adjustment, both on round hoops and flat hoops.

Mr. Ranson: The only object in having a large number of joints is that we believe the tension can be more evenly distributed on the staves, giving a tighter and better tank.

Mr. Kittredge: I do not like to see flat hoops ruled out altogether. It is entirely possible that by getting a proper quality of metal, either pure iron or something that approaches it, we can get flat hoops that will give us good service. These specifications should be broad and cover all good practice. I thoroughly agree that if the hoop is made of steel, that flat hoops would probably better be ruled out, but I don't like to see them ruled out under all conditions.

Mr. Smith: I would like to know if any members of the association have had experience in the use of flat hoops of a sufficient thickness to indicate what would happen if a thick hoop were used. It seems to me the flat hoops have been condemned on account of failures that have occurred in hoops ⅛ in. and 3/16 in. thick.

Mr. Courtenay: We have used square hoops. One objection to a square hoop is that in putting it on it is hard to keep it from turning, so that one of the corners cuts into the wood. We have a round hoop on a tank that has been in since 1886. Our experience has been that staves do not rot any more quickly when in contact with round hoops than at other places. It is a bad proposition to make a good joint with a wide, thin, flat hoop. I have had tests made with several forms of friction joints in different ways, and none of them that we have tested will develop the strength of the hoop. It is an easy matter to make a good connection with a round hoop.

Mr. Ranson: The committee would like to quote from correspondence with the inspection department of the Associated Factory Mutual Fire Insurance Companies, who have made a specification for wood tanks for use on tops of buildings in connection with fire protection.

"The strength of a tank depends chiefly on its hoops. Experience shows that flat hoops, especially those of steel, rust from the back side, where they bear against the staves, and serious accidents have happened by hoops bursting on account of this unobserved corrosion. Sometimes galvanizing or painting is depended upon to prevent rusting, but there is always the possibility that spots of the protective coating will be knocked off in handling, and one spot left unprotected may result in the failure of the hoop. Round hoops are, therefore, advised for all tanks, since, for a given cross section of metal, these hoops have the advantage of presenting the least surface to corrosion. Nearly the whole surface can, moreover, be examined or painted while the hoops are in place. In setting up a tank with round hoops there is little probability of tightening the hoops to such an extent that when the tank swells the hoops will burst; for the round hoops will simply indent the wood more as the tank swells, and the strain on the hoops is not likely to be increased to the breaking point."

Mr. Kittredge: I move that this article be so modified that it will permit the use of flat hoops.

Mr. Selby: Our road has had experience with flat hoops about twice the thickness of the average manufacturer's standard, running from ¼ to ⅜ in. and in width from 4 in. up to 6 in. Of course, these hoops are stronger, and last longer, resist corrosion longer than the thin hoops ordinarily used, but we have abandoned them for round hoops. Mr. Kittredge suggests that the objection to flat hoops may be overcome by the use of some rust resisting material, ingot iron or some material of that kind. The rapid corrosion is only one of the objections of flat hoops; the other is the difficulty in making proper connection with the lug and the unsatisfactory performance of the connection after they are installed. There is a tendency to pull the hoop away from the tub at the heel of the lug. The connection to the lug is necessarily eccentric, and the pull on the draw bolts tends to pull the hoop away and bend it immediately at the heel of the lug. This makes a weak point in the hoop, and makes a point where decay can start in the staves under the hoop.

Mr. Kittredge: I objected to flat hoops exclusively a year or two ago, and I object just as much today to the round hoops or oval hoops exclusively. I am in favor of round hoops, but I do not want to see specifications of this association leave out flat hoops. I am sure the design and structure of a flat hoop can be so worked out that it will be efficacious. I have known flat hoops to last the life of a tank. If the flat hoops are included the clause which says they may be made of steel will probably have to be modified, as well as the remarks about the flat hoops. There is a large number of flat hoops in use in this country, and we don't want it to be understood that there are no good flat hoops.

Mr. Stephens: I have known flat hoops three-eighths inch thick protected by two coats of red lead and placed on the painted surface of the tub, to be corroded through and burst off in less than eight years.

F. H. Falkinburg (B. & O.): We have found that using the round hoops, the space at the bottom of the tub, between the hoops, being greater than the width of the hoops, it is possible to renew the hoops on an old tank by beginning at the bottom, which cannot be done where flat hoops are used, because flat hoops are wider than the spaces between them.

Mr. McDonald: I think the province and object of our association is to find out what is the best thing. Although I recall an instance of a red cedar tub with flat hoops that has stood forty years, I recall a great many other instances where flat hoops have failed that have been on only seven or eight years, and I think we ought to go on record as favoring round hoops.

Mr. Loweth: Although it is the practice of the St. Paul road, and has been for some time, to use round hoops, I think we ought not commit ourselves to one line of action. The committee has done its work with a great deal of painstaking care, and has turned in an admirable report, but I think in a measure we are putting the cart before the horse. It would be much better, I think, if this committee—and I use "this committee" as an illustration of a general proposition—had come in with a report giving the reasons for and against these various things that are stated in these specifications, and this convention could very profitably have considered such a report. Let us have all the information in favor of the flat hoop, in favor of the other kinds of hoop, in favor of irons hoops, in favor of steel hoops, and all the other details that enter into a tank, and after that has been threshed out, perhaps we can agree on a specification. We have a great deal of discussion now because the committee asks—and properly, in view of our past practice—that these specifications be adopted. While it brings in a great deal of valuable discussion, it would be much better if these specifications were accepted as information. It seems to me this body of men can be relied on, if the information is furnished, to make their own specifications. We spend a great deal of time haggling over specifications that each one of us can settle for ourselves. Our committee work is largely in the nature of getting information, compiling it and getting data and the experience of others, and not in formulating hard and fast specifications. I think our work should stand for a great deal more than that.

The motion to include flat hoops was put to a vote and was defeated.

Mr. Snow: Will the committee agree to omit the specifications for iron? It is impossible to obtain this except from one or two concerns.

Mr. Ranson: The committee is not willing to accept that, as iron of this character can be purchased at the present time.

Mr. Courtenay: As a matter of information, I would like the committee to inform the association who does manufacture this quality of iron.

Mr. Ranson: The American Rolling Mill Company, Middletown, Ohio.

Mr. Tinker: I would like to say that there are a great many mills in the country that manufacture that quality of iron.

Mr. Campbell: It seems as if it were entirely practicable to produce this quality of iron, and if the association calls for that quality of iron, we will get it. I fail to see the force of the objection to including this specification for iron in these specifications, provided the specification itself is all right.

Mr. Brooke: I would like to state that the Baltimore & Ohio purchased a number of tanks last spring and had no great difficulty in getting wrought iron hoops.

Mr. Loweth: Why is asphaltum better than paint for coating tank hoops? It is harder to get and much harder to apply, according to this specification. I am not satisfied that it will preserve the hoop any longer.

Mr. Campbell: Probably the specification might be improved in that particular. I believe the committee is not wedded to asphaltum. I think coal tar might be all right, and there are paints which might be good substitutes for the material specified here.

Mr. Coburn: Speaking about pure asphaltum, the nomenclature of asphalt is a rather indefinite matter. Pure asphalt, as I understand it, is an asphalt with a considerable portion of oil. That is rather misleading.

Mr. Ranson: The committee would accept the suggestion and add a sentence to the paragraph saying "or such other coating as the engineer shall approve," leaving it open to coat the hoop in any manner the engineer sees fit.

Mr. Loweth: If paint is added last, it would seem that asphalt coating is preferred to paint. We have a good many steel and iron structures that are painted, and if paint is good for those, why is not paint good for iron hoops on a tank? We don't want paint last, as though it were something we might use, but ought to use the other.

Mr. Campbell: It has been my experience that the coating that adheres most closely to the iron is the coating that is placed there when both the material and the iron are hot. By heating the steel and immersing it in a bath of asphalt it gives a coating that adheres tenaciously to the material, and in that way I believe it is much superior to applying cold paint to cold iron.

Mr. Steffens: In case of bridge iron or other structures, the surfaces are accessible very largely. The back of a hoop is inaccessible and protected from the air. The moisture conditions, and the hoop that is in contact with the wood, which is to a large extent porous, must eventually break down the oxygen from the linseed oil. The asphaltum recommended by the committee has been known to stand, under such circumstances, over forty years. I hope the recommendation of the committee will stand as to the asphaltum coating and that we will not permit the linseed oil paint to be introduced.

The President: The amendment to the clause is the insertion of the words "or such other coating as the engineer shall approve."

Mr. Loweth: Will it be implied that any other coating will have to be applied to the hoop by dipping or immersion? There are two requirements in the specification. One is that coating shall be asphalt and the other is that it shall be applied by dipping into a hot mixture. What you add should not require it to be dipped in paint, but permit paint to be applied with a brush.

The President: The committee will accept that suggestion and insert the words, "the application of such other coating." The clause will then read: "Each hoop shall be cleaned (preferably at the factory) of dirt, rust and scale, and in that condition shall be heated to 300 degrees Fahrenheit, and be dipped in pure asphalt, or the application of such other coating as the engineer shall approve." The clause will be amended in that form.

Mr. Smith: Clause 13 says, "the tub hoops shall be half-oval or half-round," and Clause 15 says, "they shall have round thread ends." How does the committee propose to make the transition from the half-oval to half-round ends? It will conflict with our steel bridge specications, which do not permit steel welding, if the hoops are of steel and the joint is welded.

Mr. Ranson: Paragraph 15 should be changed to read, "round hoops shall have round thread ends, passing through Jugs. The joints used on half-round hoops and all others shall be as designed or selected by the engineer."

(The secretary then read Par. 17.)

Mr. Loweth: Why is it preferable to require upset ends in paragraph 17?

Mr. Campbell: An unnecessary amount of metal would be used if the ends were not upset. The strength of the rod would be limited by the strength of the metal under the thread, and these hoops are quite long. It makes a very material difference in the weight of the metal.

Mr. Loweth: At the same time I contend that for these small rods, the upsetting would cost more than the extra metal.

Mr. Campbell: The specifications say the rods should be preferably upset, but it was left to the individuals of the association to use either one.

Mr. Loweth: I move that we omit the last two lines of article 17.

The President: The last two lines will be omitted.

Mr. Lindsay: I would like to know what particular virtue the dome roof has. It does not appeal to me from an esthetic standpoint, and I cannot see any economy in it. It is difficult to make and difficult to maintain.

Mr. Campbell: The committee believes that the form of roof shown is simple and economical, as much so as any other form of roof, and probably more easily constructed than the more ordinary forms of roof. The specifications leave the description of the form of roof optional.

Mr. Lindsay: Will the committee substitute the word "will" for "shall" in the first line?

The President: That is acceptable to the committee.

Mr. Loweth: I agree that this form of roof is quite satisfactory! I think it will look well, and cost but a trifle more than the ordinary cone roof, but I would like to know why we should say the dome roof is preferable to anything else. I move that the word "preferable" be stricken out.

The President: The committee suggests the use of the word "may" instead of "shall."

Mr. Shurtleff: It seems to me that instead of going into specifications, our specifications are going into designs which will be covered by plans. I move that the paragraph be stricken out entirely and that a new paragraph be provided specifying that the roof shall be according to standard plans, which will cover the details, but the plans should not be specified in the specifications.

Mr. Campbell: On that basis we could make our specifications very short. We could simply say: "The tanks should be built according to the plans."

Mr. Loweth: Has the committee any information as to the number of railways that have built this form of roof? The committee comes and asks the association to adopt specifications in which it is stated that this type of roof is preferable. I do not know of any considerable number of roads anywhere that have been using this type of roof.

Mr. Ranson: Two years ago we attempted to get standard plans of tanks from the railways of the country. We received many answers to our inquiry, which indicated that the bulk of the railways apparently have considered the question of tank design a secondary matter, and paid very little attention to it.

Robert Ferriday: If the consensus of opinion in the association is that this form is not desirable, we would like some pretty full discussion, so that some form may be decided on in the convention here, that could be shown in our plans.

Hunter McDonald: I believe we have reached a point in the conduct of the affairs of this association when we should lay down a principle on which our work should be prepared in the future. Every time plans are presented there is continual objection, and we have never succeeded in introducing a set of plans into our manual. If we are making a mistake in instructing our committees to bring in definite specifications and recommendations, then the association should so express itself. Last year, when this question came up, the committee presented specifications, and the criticism was that they were not in sufficient detail, and it was instructed to again take up the subject and bring in specific recommendations. The committee has followed the instructions in the report it has presented at this convention. If this is wrong practice, our committee in the future, it seems to me, should be instructed to bring in only the underlying principles and leave the sketches out. I believe our convention should express itself on that theory so that our work may be properly arranged for the future, and we may not be called upon to consume the time of the convention in discussing this question of design, which is constantly meeting with opposition on account of varying standards on the different roads.

The President: Mr. McDonald's remarks are very opportune. I believe it is the province of the board of direction to lay down in its instructions to the committees some specific rules of procedure.

J. B. Jenkins (B. & O.): It seems to me it might be well for this convention to request the board of direction to draw up a preamble or preface to our manual, which would state in effect that the practice recommended in the manual is considered good practice, but that it does not exclude any other methods or plans or specifications which may arrive at the desired result.

The President: For the information of the association, I will state that the board has practically agreed on such a rule, which will appear in the new manual.

The motion to strike out clause 18 was put to vote and lost.

The President: Paragraph 18 will be amended to read: "the roof may be built," etc. It will be necessary then to amend 19, 20, 21, 22 and 23 to conform to 18. These paragraphs will be referred to the committee for amendments.

Mr. Lindsay: Does paragraph 25 confine us to the particular type of frost proofing described? There are other forms much more economical in material and as satisfactory.

P. C. Newbegin: I do not think this frost proofing as shown would answer for a very cold climate. Up in northeastern Maine, we have temperatures down to 40 degrees below zero, and the only way we found we can keep our tanks free from ice is to enclose the entire bottom of the tank and put in a stove, and run a pipe from the stove through the water in the tank and keep a fire continually in the stove.

Mr. Lloyd: I was brought up in the northwest, where they have as cold weather as in Maine, and we arranged our frost proofing in the same way as outlined in the report. We did not find it necessary to have a stove.

Mr. Loweth: I ask the committee if it is always necessary to have the water supply pipes and the discharge pipes separate? There are many cases where the two can be combined in one. This design is prefaced with the statement that the tank is designed to deliver water to locomotive through water columns. I think the practice is to separate the two pipes.

Mr. Lindsay: Our experience recently has been that the floating valve can be very much improved by the use of an automatic valve in the frost pit. The floating valve in places where you are troubled with considerable ice, is very often frozen up, and does not indicate the continuity of the supply. While I judge the specification does not prohibit the use of such a device, I call it to the attention of the association. There is also an improvement that can be made in the elbow in the frost pit, at the base of the supply pipe, where the supply pipe rises to supply the tank. If this is made a T instead of an elbow, and provided with a plug, the sediment which gathers at the foot of the supply pipe, and interferes with the supply can be blown out.

Mr. Loweth: I wish to take exception to the chairman's statement that the best practice involves the use of two pipes. That is not always true. There are times when money is saved by putting in one pipe, and letting it serve both purposes.

Mr. Lindsay: Referring to paragraph 28, a sludge hole in the bottom of the tank is a very dirty and uneconomical arrangement. When you open the hole and let the sludge out, it goes all over the substructure, and you must wash, or repaint it. There should be a pipe from the sludge hole to a suitable point on the ground. I think the sludge hole should be equipped with a better device than a plug of wood. There should be a recessed cast iron cap that could be put on the hole and tightened down so as to prevent leakage.

Mr. Lindsay: The definitions in paragraph 33, should appear in paragraph 1.

The President: The committee accepts the suggestion.

Mr. Wendt: The association is now twelve years old and there is a very sharp difference of opinion as to whether a manual should be published or not. There is also a very decided difference of opinion as to what should enter into the manual. I believe we have reached a point where the manual should contain less subject matter. The original purpose in publishing a manual probably has never been stated. I do not know what that original purpose was, except as we find on the index page of the manual, but it is my personal opinion that the greatest value of the manual should lie in the fact that it contains these general specifications, which will enable railways to obtain competition in the purchase of materials. It should contain well defined principles which could be followed by engineers generally.

It may or may not be desirable to introduce standard plans in the manual, but I think it is quite out of the question to introduce into the manual standard designs of structures. We have reached the point where it would be fair to lay down the general principles that committees may well prepare standard plans, not with the object of having them adopted as parts of the manual, but for the purpose of having them approved as information, as to best designs suitable to definitely prescribed conditions. I move that the report of this committee on specifications for wooden water tanks be received as information.

The motion was carried.

After some discussion as to the time available for considering the report of the committee, a motion that the report be received as information was carried.

WOOD PRESERVATION.

The following sub-committees were appointed.

Revision of Manual: Octave Chanute, chairman; V. K. Hendricks, G. M. Davidson, Walter Buehler.

On Specifications for New Processes: V. K. Hendricks, chairman; A. L. Kuehn, E. H. Bowser, G. E. Rex, W. Buehler, E. Stimson, H. F. Weiss.

On Grouping: H. F. Weiss, chairman; Octave Chanute, E. A. Sterling, A. L. Kuehn.

On Specifications for Timber and Piling: Herman Von Schrenk, chairman; L. Bush, W. H. Courtenay, W. K. Hatt.

On Statistics: Octave Chanute, chairman; W. H. Courtenay, E. A. Sterling.

On Track Scales for Weighing Ties: Herman Von Schrenk, chairman; Earl Stimson.

Revision of Manual.

Certain changes have been recommended in the specifications for creosote oil, which are summarized as follows:

Paragraph 1. The definition of creosote oil restricts its origin to coal tar, and allows an admixture of refined coal tar to the creosote oil.

Paragraph 2. Fixes the per cent of insoluble matter at 2 per cent. This is necessary to control the amount of free carbon in the oil when coal tar is added thereto.

Paragraph 3. Places an upper limit of 1.10 on the specific gravity. This limit is placed arbitrarily, for as the gravity of oil for paving blocks has been fixed at from 1.10 to 1.15, it would seem that the oil for treatment of ties and timbers should not have any higher gravity than the paving block oil.

In paragraph 5 it is specified that the fraction between 210° and 255° C. shall deposit naphthalene salts on cooling, and the fraction between 315° and 355° C. shall yield solids on cooling. The demand that the oil shall not show any evidence of decomposition as indicated by the presence of dense white fumes in the condenser is intended to guard against adulteration from water-gas tar.

The committee recommends an additional paragraph to the recommended practice providing for accurate tests of the life of ties, in an especially selected and carefully inspected test track. While it is thought that the use of the dating nail in each tie is justified by its educative value to trackmen and others, yet the accurate determination of the relative life of ties, and their behavior under service, demands a more careful supervision at the hands of trained assistants than is possible under the present system.

The sub-committee for piles and timber to be treated proposes an addition to recommended practice providing for the framing of timbers before treatment.

Specifications for New Processes.

The sub-committee on specifications for new processes reports that it is impracticable to write specifications for patented processes. They have, therefore, obtained from the persons in control of such processes an accurate description of the method of conducting them.

Specifications for Piles and Timber to be Treated.

The sub-committee presents a draft of such specifications for discussion. The present standard specifications of the association have been followed, as far as possible, except that sap restrictions have been removed. With the endeavor to call the attention of the mill men to the desire of the consumer to obtain material with a large amount of sap, rather than all heart pieces, the statement is made in the specifications that sap wood is to be preferred. The reasonable exception is that this change would operate to reduce the cost of material.

Track Scales for Weighing Ties.

The specifications adopted last year for tie treatment provided for the occasional weighing of buggy loads, in and out of the cylinder. The subject of track scales has been investigated by the sub-committee, which finds that track scales for weighing ties are now being used occasionally in treating plants in this country and quite generally in Europe. It recommends that a track scale be installed at every treating plant wherever possible.

Strength of Ties Treated with Crude Oil.

Last year's report on Strength of Treated Timber mentioned certain tests of ties treated with crude oil. Subsequent tests on the same ties show that the temporary softening of the surface had disappeared upon exposure, but that the reduction of the spike-holding power in the treated ties still remains.

Conclusions.

(1) That the revised specifications for creosote oil be adopted for publication in the Manual.

(2) That the two paragraphs recommending the selection of a section of track for testing the life of ties, and recommending the framing of timbers before treatment be added to the recommended practice of the association.

The report is signed by: W. K. Hatt, Purdue University, chairman; W. H. Courtenay, L. & N., vice-chairman; E. H. Bowser, I. C.; Walter Buehler, Kettle River Company; Lincoln Bush, Consulting Engineer; G. M. Davidson, C. & N. W.; George E. Rex, A. T. & S. F.; V. K. Hendricks, St. L. & S. F.; A. L. Kuehn, American Creosoting Company; E. A. Sterling, Pennsylvania; Earl Stimson, B. & O.; Hermann von Schrenk, R. I.; Howard F. Weiss, United States Department of Agriculture, committee.

Appendix H.

Electrical Resistance of Timber as Affected by Treatment with Preservatives.

An investigation to determine the resistance of ties as affected by treatment with preservatives was made by Mr. J. T. Butterfield, of the School of Electrical Engineering at Purdue University ,in the spring of 1910.

The material available for the tests consisted of four shipments of ties. The specimens tested vary in size from half a tie to a small section cut from half a tie.

The resistance was measured by the method commonly used for measuring the insulation resistance of electrical machinery, namely, by means of a direct current voltmeter of known resistance. This method was applied in two ways: (1) The contact surface for flow of current in the ties was a sawn surface as nearly plane as possible. Contact pressure of 250 lbs. per sq. in. was applied in a Riehle testing machine by means of sheet-iron pans, placed one above the other and filled between with dry sand, by which constant surface resistance was obtained. (2) After some of the fundamental laws were investigated, the resistance of the various ties was compared by measuring the current flowing between two spikes driven 20 in. apart in the face of each tie. Then the relation of these latter tests, between the two spikes, to the conditions obtaining in a full tie with rails spiked thereto was investigated.

In beginning the tests the principal elements which cause the resistance to vary were determined and investigated in the following order:

(1) Amount of moisture present. (2) Kind of wood. (3) Treatment. (4) Direction of grain. (5) Contact pressure. (6) Temperature. (7) Amount and time of current flowing. (8) Dimensions of specimen.

The results obtained tend to establish the following conclusions: Timber is ordinarily classed with the non-conductors. When dry and well seasoned, it has a very high dielectric strength and practically infinite resistance. When green or moist, however, timber becomes a kind of electrolytic conductor of comparatively low resistance. The treatment with zinc preservatives has the simple effect of producing in the wood a stronger electrolyte and hence a better conductor of current.

(1) The resistance of timber varies directly with the length and inversely with the cross section.

(2) The resistance of timber varies almost inversely with the amount of moisture present, between the limits of 15 and 50 per cent.

(3) The resistance of timber is lowest when measured along the grain, and highest when measured tangentially to the growth rings.

(4) When treated with a soluble salt such as zinc chloride, the resistance varies approximately inversely as the amount of the salt present.

(5) Treatment with such a soluble salt does not change the behavior of the resistance with respect to the per cent moisture present. Only the amount of the resistance is changed.

(6) The resistance of timber varies almost inversely with the temperature between the limits of zero and 30 degrees Centigrade.

(7) The resistance of non-porous woods, such as the pines, is higher than that of porous woods, such as the oaks and red gum.

(8) Treatment of timber by different creosote processes does not greatly change the natural resistance of the timber.

(9) Finally, all the data taken go to establish the view that the conductivity of wood is due primarily to the presence in the pores of an electrolyte formed by an aqueous solution of the salts found in the natural timber, or of these salts and others artificially introduced.

Assuming the worst condition for leakage covered by the test, i. e., red oak ties treated with zinc chloride laid in wet ballast and with wet rail bearings, the resistance between the rails of a block one mile in length would approximate 30 ohms. This would permit a leakage current of .05 ampere to flow with the battery voltage of 1.5 volts. The leakage loss would, therefore, be .075 watt, or about 30 per cent of the power required to operate the relay. This should not seriously interfere with the operation of signals, as leakages up to 60 per cent exist without such serious interference.

It is to be regretted that determinations of resistance were not made with wet ties or with ties and rails partially immersed in water, as is sometimes the case in practice, for it is believed that under such condtions the leakage current would probably be sufficiently large to interfere with the successful operation of relays.

As a final conclusion, it should be noted that since the above results show only a reduction in resistance of a tie of from 26 to 53 per cent when treated with zinc chloride, depending upon the percentage of moisture, while a change of resistance by the ratio of 25 to 1 may be effected by varying the kind of wood, a change of 33 to 1 by varying the pressure upon the tie sufficiently, and of 3.7 to 1 by temperature changes, it follows that the treatment of ties with preservatives should not interfere with the operation of signal circuits, except possibly in exceptional cases in which the resistance of the leakage paths is abnormally low from other causes.

Discussion on Wood Preservation.

Mr. Courtenay: The committee requests that no consideration be given to conclusion (1), "That the revised specification for creosote oil be adopted for publication in the manual," and that the association refer that conclusion back to the committee for future consideration. The committee would also desire to withdraw from the consideration of the association Appendix A.

The President: The committee is willing under conclusion (2) that the recommendation with reference to the selection of track for testing the life of ties be submitted to the board of direction for its action. The recommendation of the committee in conclusion No. 2 that the framing of timbers before treatment be added to the recommended practice of the association is open for discussion.

C. E. Smith (Mo. Pac.): It is not practicable in all cases to frame the timbers, including the boring of holes, before treatment. Take, for example, a cap on a pile. It would not be practicable to bore the hole in connection with the sway brace before it was put on. It would not be practicable to bore the holes for the chord bolt through the stringers. I think the committee should specify a treatment for such timber as must be worked in the field after the timbers have been treated.

Mr. Courtenay: The only thing that can be done is to mop such surfaces with creosote oil, which is a very simple process.

Mr. McDonald: Where it is necessary to bore holes in timber after they have been treated, if the holes are vertical, they should be plugged, and filled with creosote, and the creosote allowed to soak in. Where it is necessary to frame small timbers which can be handled, it will be found the best treatment to immerse the frame end in hot creosote, permitting it to remain for about twenty minutes, taking it out, and immersing it in cold creosote, and permitting it to remain a similar length of time. That cannot be done where you saw off the end of piles, nor in the case of large timbers. Something better than mopping should be insisted upon, if it is possible to do so.

Mr. Courtenay: The Louisville and Nashville has been using creosoted timber in its trestle structures on a considerable scale since 1876. For that reason, our bridge supervisors have accumulated a great deal of experience with this material. We have adopted various expedients and endeavored so far as possible to frame creosoted material before it is creosoted, and have gone to the length of taking green timber, framing it, regularly erecting it in the structure, to insure a fit, and then taking it down to creosote it. After a long observation in the use of creosoted bridge timber, we find that with good hard yellow pine, it is almost impenetrable and that we can hardly get a penetration of the creosote of one-quarter inch. We have creosoted timber in these structures which has been there since 1876, and is apparently very good today. We have tried mopping with hot creosote oil, and have endeavored to get information concerning it from our supervisors of bridges and buildings over about fifteen divisions. There is a difference of opinion as to whether it is effective. It is the best thing we have been able to devise at reasonable cost.

Mr. Smith: I do not think this association should express its approval of putting frame timbers in a structure and then taking them out and shipping them to some point for treatment, and I trust the committee will amplify this portion of the subject by giving some method of treatment in the field.

C. F. W. Felt (Santa Fe): On the Galveston viaduct, we used a marine treatment. We have no trouble with decay on that bridge. We used the 24-pound per cubic foot treatment. It is our rule to mop the timbers with hot creosote, and also with asphalt on the ordinary ballast deck construction.

Mr. Courtenay: In 1882, a pier was constructed at Pensacola, Fla. Alongside of that pier, at every opening, there were a number of mooring piles standing high above the pier. The tops of the piles were exposed to the sun. They were necessarily cut off to the proper height above the top of the pier. The tops of the piles were mopped with creosote oil and in addition had a thick covering of hot pitch with some lime mixed with it. In 1887, the heart wood in the tops of a number of these mooring piles was so rotten that a man could pick out a conical shape plug with his fingers. Other piles lasted much better. Nearly all of them are exposed to the rays of the sun. When a pile is creosoted, and driven, and you cut off the top of the pile to get proper bearing for the cap, the top of the pile under these conditions does not rot. We had creosoted timber, heart pine, put in trestle structure between Mobile and New Orleans and covered with two feet of sand, put there in 1886, and the timber is good today, and as far as I know, they are the first ballast deck trusses of creosoted wood

put in such a manner as to be protected from the action of the sun and to avoid the exposure of the creosoted portion. Our experience is that pick holes in the sides of the piles will not hurt them much, but if a man scrapes along the sides of the piles, in order to make the bracing fit better, he is ruining his material.

W. F. Goltra: The demand for a speedier and more efficient method of kiln drying or seasoning ties is well known to those who have given that subject any attention. The seasoning of ties in the open air is slow and unsatisfactory. They can be artificially dried at much less expense and very much quicker than they can by open air seasoning. Ties or timber have to be dry, before they can be treated, and it has been the custom of railways and some manufacturers who use wood for implements for furniture, etc., to stack the material in the open air. The ties can be dried artificially at an expense of only 1¼ cents each for fuel. That is less than the interest on the capital which is held up by ties stacked in the open air for seasoning, and is much less than the deterioration of the ties which takes place while they are seasoning. Should not this committee be instructed to investigate the kiln drying of ties or timber versus the open air seasoning?

BUILDINGS.

The following sub-committees were appointed:

Roof Coverings: Maurice Coburn, chairman; H. M. Cryder, C. H. Fake, P. F. Gentine, H. Rettinghouse, C. W. Richey.

Tool Houses: William T. Dorrance, chairman; Geo. W. Andrews, J. P. Canty, D. R. Collin, M. A. Long.

Reinforced Concrete Coaling Stations: E. N. Layfield, chairman; John S. Metcalf, O. P. Chamberlain.

Reinforced Concrete Coaling Stations.

A number of reinforced concrete coaling stations have been built since the report of last year, notably one by the Philadelphia & Reading at Philadelphia, with a capacity for handling 700 tons of coal per day of 10 hours and with a storage capacity of 2,000 tons.

The committee has no further report to make, but desires to have the subject referred back to it for the purpose of noting and reporting on the operation of the stations already built and the progress in designing new ones.

Roof Coverings.

Bituminous Roofing Materials.

Information concerning the relative value of the bituminous materials for roofing is not easily available. The detailed knowledge held by the leading concerns preparing the materials has been acquired by expensive experience and is regarded as a valuable asset not to be shared by possible competitors and the ignorant purchaser.

The bitumens are compounds of many different hydro-carbons with different chemical formulae and widely-varying melting points. They are always accompanied by greater or less amounts of impurities, and are obtained either naturally or as the heavier distillates or residues of coal, petroleum or other organic substances. Their distinguishing characteristics are their elasticity and binding power or adhesiveness, their considerable immunity from action by water and their solubility in oils and certain other organic compounds.

Asphalt.—The term asphalt is ordinarily considered as referring to bitumens found naturally in the solid state and will be so used in this discussion.

The asphalts are generally stable in the atmosphere. As found naturally, they are not commercially available, even after the impurities are removed, being too hard and brittle for most purposes. This is ordinarily remedied by softening or fluxing with various oils, an operation requiring skill. The character of the fluxes has a most important effect upon the finished product. Petroleum products are ordinarily depended on for this purpose. The fluxes should be sufficiently stable to insure against too rapid hardening of the fluxed asphalt. They should be free from deleterious constituents and should be of such a character that they will combine with the asphalt to be fluxed so as to make a homogeneous and perfect solution. Certain fluxes which work well with certain asphalts are not at all suitable for use with other asphalts. Poor results are sometimes supposed to be due either to chemical action in the fluxes or to chemical action between the fluxes and the asphalts. Tars are sometimes employed for fluxing purposes, but they do not mix easily with the asphalt. As asphaltic compounds age they tend to become brittle and hard, losing their elasticity and binding power. Poor fluxes hasten this process.

Tars.

Coal Tar.—From the distillation of bituminous coal, either in a plant for the production of illuminating gas or in a by-product coke oven the products may be roughly divided into four classes, the gas, the ammoniacal liquor which is the scrubbing water with the materials which it has absorbed from the distillates and which it holds in solution, the coal-tar, a heavy liquid containing the distillates insoluble in water which have settled away from the ammoniacal liquor and the coke.

The coal-tar contains some water, various impurities, and free carbon which after the water has been removed, is ordinarily from five to thirty-five per cent of the total. This is carbon formed by the cracking of the hydrocarbons and is in a very finely divided condition. The percentage varies with the method of manufacture. The distillates or bitumen are composed of hydrocarbons which have widely-varying melting-points, and degrees of volatility. These may be roughly classified into light oils, creosotes and pitches. The character of the tar varies with the coal used and the manner in which the process is carried on. The greater the heat, the more the hydrocarbons are cracked into their constituents and the greater the amount of free carbon and of gas found and the less the amount of coal-tar. The question of the relation between the free carbon and coal-tar is one of considerable importance. It is generally considered to be a valuable adjunct to roofing tars and pitches. Free carbon makes the material less affected by changes in temperature. Comparing two pitches of similar consistency at normal temperatures the one having the greater amount of free carbon must have to neutralize a greater per cent of the lighter, more elastic and to some extent more volatile hydrocarbons and less of the heavy pitches. When it is cold the pitch is less brittle and when it is hot does not flow so readily because of the carbon present. Thus a tar of a given consistency may notwithstanding the fact that it contains large quantities of an inert material apparently have more life than another with less of the free carbon.

When coal-tar pitch is exposed to the weather there is found upon its surface a thin layer, hard and brittle, the residue after the drying out of the volatile oils. This acts as a sort of protective coating to what is underneath. As soon as it is disturbed, exposing fresh pitch, the process is repeated. High carbon tars seem to weather better than low carbon tars, the increased amounts of free carbon seeming to aid in the foundation of the skin or protective coating.

Watergas Tar.—Watergas is made by passing steam over hot coke or anthracite coal, which decomposing the steam, forms carbon monoxide and hydrogen. This does not possess sufficient illuminating power, and to enrich it, there is added a gas produced from petroleum which leaves a tar often used in place of coal-tar. In the process which it undergoes the oil residues are so changed by the high heat as to lose many of their characteristics and to acquire some of those of the compounds found in coal-tar. Compared with coal-tar, its oils have less antiseptic properties. As obtained from the gas manufacturers it is thinner, containing more water, more light oils and less of the pitches and no free carbon. It is distilled down and treated much as is coal-tar and its pitch is very similar in appearance to that of coal tar.

Watergas tar decomposes easier than coal-tar. It often contains some paraffine though ordinarily not in sufficient quantities to affect the product. The crude watergas tar is also much more affected by water and is capable to a considerable extent of forming an emulsion with it. Good coal-tar is practically unaffected by water, and it deteriorates from the surface only. Oil tar products like the oil fluxes used with asphalts are liable to undergo chemical changes which may tend to make the entire mass hard and brittle.

Not long since practically the only use of tar was for roofing and the entire supply came from the manufacture of illuminating gas from coal. The situation has been changed by the increasing supply from by-product ovens, by the manufacture of watergas in large quantities, by the great demand for creosote oils and other by-products, by the use of coal-tar for water-proofing masonry, by its use for briquetting coal slack and by its adoption for use as a road binder as a protection against the ravages of the automobile.

With skill in compounding, based on a thorough working knowledge of the materials used, asphaltic compounds can be prepared of natural asphalts and oil residuals with valuable qualities for many different roofing needs, whose durability under known conditions can be foretold with considerable accuracy. The same can be said, perhaps with more certainty as to results, of the different tars. Either can suffer from adulteration and poor preparation. Considering first-class materials the coal-tar is cheaper, more easily affected by temperature changes, and is not acted upon by water nor is it liable to internal chemical changes.

Felts.

The felts used with almost all bituminous roofings play a very essential part in the final product.

The desirable qualities of the felt vary with the saturating material to be used. With asphalt, saturating power is the main desideratum. For coal-tar which under heat is much more liquid, this quality is not so necessary. All must be strong enough to avoid damage in handling before saturation. The strength of the finished product is due to a great extent to the saturation.

The felts are mainly made of rag stock which is chiefly cotton rags. The best felts for saturation by asphalt rarely contain more than 25 to 35 per cent of wood, and those for use with coal-tar contain much less. As ordinarily used the term wool-felt applies to a soft felt with very little wool in it.

The methods of manufacture have a considerable effect on the quality of the material. The felt must be well beaten to avoid large lumps, which are sources of weakness. The felt is made on a machine similar to that used for making ordinary paper and variations in its operation determine the quality of the finished products.

The dry felts are sold by weight. The standard is the amount which would lay 480 sq. ft. If a felt weighs 28 lbs. to 480 sq. ft., it is known as No. 28. For this reason felts sometimes have their weight increased by the addition of a mineral filler. This is nothing more than an adulterant which interferes with the saturating power.

Felts of asbestos are used in one or two roofings. These are poor saturants and are more in the nature of protection to the asphalts. They will not burn or decay.

Built-up Roofs.

The main use of tar for roofing has been in the construction of built-up roofs where layers of felt saturated with tar are nailed down and by the use of a tar pitch protected and cemented together.

The following specification accompanied by the necessary diagrams give what is considered as good practice in the construction of a flat built-up roofing on wooden sheathing.

Specification.

Roofing.—First, lay one (1) thickness of sheathing paper, or unsaturated felt, weighing not less than five (5) lbs. per hundred (100) sq. ft., lapping the sheets at least one (1) in.

Second, lay two (2) plies of tarred felt, weighing fourteen (14) to sixteen (16) lbs. per hundred (100) sq. ft., lapping each seventeen (17) in. over the preceding one, and nail as often as is necessary to hold in place until remaining felt is laid.

Third, coat the entire surface uniformly with straight run coal-tar pitch.

Fourth, lay three (3) plies of tarred felt, lapping each sheet twenty-two (22) in. over the preceding one, mopping with pitch the full twenty-two (22) in. on each sheet, so that in no place shall felt touch felt. Such nailing as is necessary shall be done so that all nails will be covered by not less than two (2) plies of felt.

Fifth, spread over the entire surface a uniform coating of pitch, into which, while hot, imbed not less than four hundred (400) lbs. of gravel, or three hundred (300) lbs. of slag, to each one hundred (100) sq. ft. The gravel, or slag, shall be from one-quarter (¼) to five-eighths (⅝) in. in size, dry, and free from dirt.

Flashing.—Flashings shall be constructed as shown in detailed drawings.

Labels.—All felt and pitch shall bear the manufacturer's label.

Inspection.—The roof may be inspected before the gravel or slag is applied by cutting a slit not less than three (3) ft. long at right angles to the way the felt is laid.

N. B.—To comply with the above specifications, the material necessary for each one hundred (100) sq. ft. of roof are approximately as follows: 100 sq. ft. sheathing paper, 80 to 90 lbs. tarred felt, 120 to 160 lbs. straight run coal-tar pitch, 400 lbs. gravel, or 300 lbs. slag.

In estimating felt, the average weight is practically fifteen (15) lbs., per one hundred (100) sq. ft., and about ten per cent (10%) extra is required for laps.

In estimating pitch, the weather conditions and expertness of the workmen will affect the amount necessary for the moppings, and to properly bed gravel or slag.

In the final coating of a coal tar roof the effort is to get the maximum amount of pitch coating which can be kept in place. The flatter the roof the greater the amount of pitch that can be used and the better both pitch and gravel will stay where put. The best results are obtained when the slope of the roof is only enough to allow it to thoroughly drain. When it gets above two inches to the foot many object to its use, but the above specifications are considered by others as good practice up to three inches to the foot.

Where thorough inspection is not provided during construction the roof can be inspected by cutting a strip three feet long at right angles with the way the felt is laid before the gravel is applied. This can be readily repaired so that no damage is done to the roof.

As an indication of what can be done in territory adjacent to Chicago and St. Louis, the following figures may be of interest. They show actual costs on a roof of about five hundred squares laid according to the specifications given above. The work was seventy-five miles from the gravel supply and one hundred and seventy-five miles from the headquarters of the contractor, who paid all freight and fare. This work was done close to a railroad track, so that nothing was necessary for hauling to the work. Nothing is included for overhead or fixed charges or for profit.

Cost per square:

5 lbs. sheathing paper	$0.12
155 lbs. pitch at 60c per cwt	.93
85 lbs. felt to square at $1.40 per cwt	1.19
Nails and caps	.05
Cleats for flashing	.05
Gravel (about one-seventh of a yard)	.23
Labor, including hauling, board and railroad fare	1.15
	$3.72

Plastic Roofing.—This is a sort of built-up roof used especially on steep slopes, where in place of using ordinary roofing pitch we have a compound of some fine inert substance with tar or some other bituminous material which is plastic when warm and which can be applied with a trowel. It is not extensively used and its application is mainly confined to the eastern part of the country. Except for steep slopes it has little value, as it lacks elasticity and because it requires considerable skill to get the proper proportions.

Built-Up Asphalt Roofing.—Built-up asphalt roofs have been used with considerable success. Asphalt is much less affected by temperature changes. For a roofing cement it must have considerable proportions of flux to make it easy of application. Coal-tar felts are often used with asphalt roofing cements. With asphalts, the dry sheet can ordinarily be avoided. Where first-class material is used it is ordinarily expensive and it is harder to handle. Except for steeper slopes than are suitable for coal-tar, its use is not recommended unless unusual conditions make it more economical.

Built-Up Asbestos Roofing.—There is on the market materials for a built-up asbestos and asphalt roof. The asbestos, besides its well-known fire-resisting value, has the advantage that, being mineral, it will not decay. It is not as absorbent as felt and acts more as a protection to the bitumens than as a saturant. This roofing is ordinarily applied only by the manufacturers. The fire-resisting value of the asbestos is perhaps overrated and the wearing qualities of the top layer are questioned.

Prepared or Ready Roofings.

To compete with it and to meet some of the conditions where a built-up roof is not satisfactory or too expensive, innumerable prepared or ready roofings have been put on the market. These ordinarily come in rolls accompanied by the nails and cement necessary to apply them. They vary from a very light felt with the cheapest possible saturant and enough sand or soapstone coating to prevent sticking in the rolls, to a sheet so heavy that it cannot be rolled, built up of heavy felts and strengthening materials and saturated and protected by carefully prepared compounds, possibly protected also by a coating of crushed stone.

The saturant should be liquid enough at workable temperatures to thoroughly impregnate the felt. The protective coating should be stable and not easily affected by the elements. The saturation of the felt is a very vital feature. This must retain its life and elasticity to keep the roofing efficient. A protective coating of material similar to the saturation is often used with the idea of helping to maintain the life of the saturating material.

The prepared roofings may be divided into two general classes—smooth and stone-surfaced. The stone-surfaced roofings are to a certain extent an adaptation of the built-up roofings. They frequently have at least two felts cemented together. The gravel or slag used must be uniform in size and finer than that available for built-up roof. The steeper the roof the more chance they have to lose their stone coating. The amount of material that can be used in the heavier brands is limited to the amount that can be successfully rolled. If the stone be too large, it may damage the felt in rolling; if too small, the amount of pitch is limited.

Tarred felts in which there are two or three plies of felts cemented together with pitch are sold ready to be laid. They must be covered with a tar coating upon laying and at frequent intervals to show any value at all.

The asbestos roofings are made to include one or more plies of asbestos felt, with possibly a jute center. They are cemented together by asphaltic cements. In the heavier brands they are expensive. The asbestos felts are poor saturants. These roofings have given promise of good results and are widely used. The asbestos will not burn, but the amount used is so small that its insulating value is not great, and the value of these roofings from the standpoint of fire protection is probably frequently over-estimated.

Burlap or jute canvas is used in ready roofings as a strengthening material. It is not a good saturant and must be kept thoroughly coated, as otherwise it goes to pieces readily. It is employed in conjunction with either felts or asbestos sheets. We question its value, feeling that better results can be obtained from a proper quantity of ordinary felt.

The use of tin caps under the head of nails to secure prepared roofing should be avoided. When used, they must be kept constantly coated to prevent the rapid distintegration of the steel plates of which they are composed. If this occurs the nail head stands clear of the roofing, which is then an easy prey to wind storms. Care should be taken in the flashing and around the edge of the roof to have it thoroughly fastened down. Nails of a No. 12 gage wire with a cap made of cold-rolled hoop steel welded on in the factory are used for this purpose. Some recommend nailing every two inches, but with large-headed nails every three inches is usually considered enough.

One of the chances for trouble with many of the ready roofings is their tendency to stretch and wrinkle and the difficulty in laying them absolutely tight and flat. As the roofing grows older and brittle the wrinkles become danger spots which are liable to crack if walked on. The roofing should be as thoroughly stretched as possible in laying. Knot holes should be covered before applying the roofing. In cold weather it is well to warm the rolls to avoid any chance of cracking.

The ready roofings usually commence to show deterioration after they have been kept in stock for three or four months. In purchasing care should be taken to avoid old material.

The ready roofings are of value for small and isolated buildings where the cost of laying a built-up roof would be excessive and for temporary structure where a roof of long life is not necessary. They can be laid without the expert help required for a built-up roof and most brands can be used on any slopes, although on flat slopes extra precautions must be taken to prevent leaking. They can be obtained at almost any desired price, but ordinarily cheaper than a good built-up coal-tar roof.

Most of the ready roofings are sold under a five or ten years' guarantee, and many contracts for built-up roofs are similarly prepared. To depend upon these guarantees alone does not give satisfactory results even though the manufacturer be financially responsible. He can expect more immediate profit by preparing a roof which he is sure will last six or seven years and selling it under a ten years' guarantee than by preparing a roof which he is sure will last for ten years. At best the life will be uncertain and with good luck a roof built for six or seven years or even less might last twice as long. If it should need extensive repairs before the guarantee runs out there is considerable chance that the manufacturer will not be called on to make the repairs, and if he is, the loss is not great. Guarantees are liable to be so worded as to accord various loopholes for avoiding expense and they should, if relied on, be carefully scrutinized. A good roofing should last much longer than any possible guarantee can provide for. If the guarantee is made good, there still may be nothing left at its expiration.

Wood Shingles.

A wood shingle roof properly laid and of good material will last for many years. Good shingles can still be obtained from the Pacific Coast for a reasonable price, though not equal to the white pine formerly obtainable. The nails ordinarily corrode before good shingles have deteriorated noticeably, allowing the shingles to become loosened and displaced. If the shingles are dipped in linseed oil or creosote their life will be considerably increased. Painting after laying with a linseed oil paint induces decay and should be avoided. The main objection to shingles is their fire hazard. When the roof is old and a little out of shape, it is especially dangerous, providing a chance for the lodging of sparks. It must have a pitch of not less than six inches to the foot.

To avoid the chance of one joint coming over another, they should always be laid with at least three laps. With a 16-inch shingle not more than 4¾ inches should be exposed. There should be two and only two nails in each shingle.

Slate.

Slate comes with considerably varying qualities. It should be hard and tough and have a well-defined vein which must not be too coarse. If too soft it will absorb mixture. If too brittle, it cannot be cut and punched without splitting, and it will easily be damaged by walking on the roof. Crystals are sometimes found which disintegrate on exposure to the weather. Acid gases in the air and freezing of absorbed water tend to cause a disintegration of the slate. A clear metallic ring when struck is an indication of soundness. A cracked or soft slate gives a muffled sound.

Slate should not be laid on a roof having less than a one-quarter pitch, and a one-third pitch is better. When it is flatter than this it is liable to leak from capillary attraction. Finely powdered snow, driven under the slate by high winds and, later on, melting and freezing, is liable to cause damage to a slate roof. To be sure of the best results it should be laid on a good waterproof felt. In nailing slate each piece should be secured by two nails. Where exposed to gases the nails should be as far as possible non-corrosive, as they frequently determine the life of the roof.

In laying, care should be taken to avoid cracking the slate by driving nails carelessly or too tight.

Tile.

Clay roofing tile, unglazed without being hard burnt, is more or less porous and moisture is liable to cause damage in freezing weather. If glazed, the glaze, if improperly made, is liable to decompose on exposure to the elements. Properly made, good roofing tile cannot be excelled for durability. With tile it is a little harder to get a tight roof than with slate. Interlocking shapes

have been devised giving very good results in this respect, although there is liable to be danger from driving rain or snow. Sometimes the tile is bedded in a plastic cement, but ordinarily, to be sure of the best results, it is laid on a good waterproof felt. When laid on a close wood sheathing it is held in place by battens nailed horizontally on top of the sheathing and is fastened down by wire. Copper wire, not less than No. 12 gage, could be used for this purpose. Steel wire or bands are liable to corrode.

Tiles should not be used on a roof having a pitch of less than six inches to the foot.

Iron or Steel Roofings.

The further the material varies from pure iron the more liable it is to corrosion, and a great deal of the trouble in such roofing is due to the poor steel used, which will not last more than a few years, no matter how protected.

During the past few years a very pure iron, made by new processes, has been put on the market. Laboratory tests would indicate that excellent results may be expected from this material. It is cheaper than charcoal iron, but more expensive than steel. We believe that its extensive use is justified but that it has not yet been tried in actual service long enough to warrant any positive recommendations.

Corrugated Iron or Steel.—Owing to the difficulty in getting good iron for this purpose this roofing is ordinarily avoided for railroad work. Galvanized, it does not give good results. If pure iron can be obtained, this material may be valuable for use in roofing certain buildings, such as some types of shop buildings and open umbrella shelter sheds.

Asbestos protected metal, lately introduced, is corrugated steel which is used with a bituminous coating covered with asbestos as a protection to the steel plate. This has not been in use long enough for any definite opinion to be given in regard to it.

Metal Shingles.—Metal shingles are used to some extent by different railroads. Of good material and properly protected, they have their uses.

Tin Plate.—Tin plate has a body of iron or steel. The coating is in most cases an alloy of lead and tin, with lead usually predominating. When tin is specified, the coating should consist of not less than 30 per cent pure tin, nor more than 70 per cent pure lead. Not less than 20 pounds of the coating should be used per box of 112 sheets 14 inches by 20 inches.

Where the coating is all of lead, it is called terne plate, and is used when cheapness is an object.

Good tin plate for roofing can still be had, and where it is desired to use this material for roof covering one of the reliable brands of hand-dipped plate not less than IX or No. 28 gage should be selected. Rolled tin plate should not be used for roofing, guttering or valleys.

One method employed in the preparation of steel for roofing purposes is to pickle the steel in acid baths to cleanse the sheets of scale and dirt. Unless this process is most carefully followed by thorough cleansing, minute particles of acid remain to form within the plate itself an agent for its final destruction.

Tin roofing must be painted with a good paint to preserve it. Tin roofings can be shown which have lasted twenty or thirty years on railroad structures, but the danger of securing poor material and the cost of maintenance have made conservative builders very cautious in its use. It has the great advantage of being available for all slopes and it is adaptable to special and difficult conditions.

Plates for tin roofing should be prepared in the shop, and one side for use next to the sheathing given a coat of good paint. In soldering these sheets rosin and not acid should be used, as the latter may find an opening in the tin coat and attack and destroy the body.

Miscellaneous Metals.

Sheet Lead.—Sheet lead has been used abroad considerably. Its main value is due to its immunity from action by acid gases, but it is expensive. It has a tendency to cold flow from its own weight and it expands rapidly under heat.

Copper.—Good copper is not easily corroded, but it has a high rate of expansion and is expensive. It is not always possible to secure it of good quality, and impure it corrodes much more rapidly than it should. It is only desirable for railroad buildings in rare cases.

Copper and Nickel Alloy.—For expensive building an alloy of copper and nickel is sometimes used which is said to be practically non-corrosive. It works much like sheet copper, but is harder.

Concrete Roofings.

Reinforced concrete tile, several square feet in area, have been used to a considerable extent on large sheds and factory buildings where the slight leakage from their somewhat open joints is not objectionable. They are usually placed directly on the purlins and kept in place by wiring to the framework. They must be carefully made from good materials and made as dense as possible. Improved methods of forming under pressure may improve their quality. Their use as yet is largely experimental.

Small cement tile are in use to a limited extent and the criticism given concerning the reinforced tile also applies to them. They are less expensive than clay tile but are more absorbent and brittle. Improved methods of manufacture and further tests may later develop their merits for some purposes, but no economy has so far been shown by their use.

Asbestos shingles and corrugated sheets made of Portland cement and asbestos under pressure give promise of good results. They can be made in different colors and have some desirable advantages. They have not been in use long enough to prove their merit.

Methods of Application.

Sheathing.—Wooden sheathing improperly laid has caused the value of many good roofings to be underestimated. Green lumber should never be used for this purpose, as it will shrink in drying, with a resultant distortion of the covering material. With a prepared roofing the felt will be given a wavelike appearance and the seams or joints forced open. With a slate roof the slate will be liable to be broken or loosened. Tin or copper coverings may be subjected to open seams and on a tile roof the shoulders in an interlocking type will be broken off. Sheathing boards should be surfaced to a uniform thickness, and ordinarily a plain board will be satisfactory. The sheathing should be thick enough to prevent the roofing nail from going through it. On some types of buildings the building should be stiffened by running the sheathing diagonally to the rafters and purlins. The nailing should be reduced to a minimum.

Gutters.—The use of gutters on railway shops and on buildings close to the track should be discontinued where it can be done without causing inconvenience. The cost of cleaning and maintenance are considerable because the sparks and shop dust that accumulate at such points contain injurious acids. The roof drainage can frequently be taken care of by a cement gutter on the ground to carry it to sewers or drains.

For railway purposes copper gutters are ordinarily the most economical when metal is used. Hand-dipped tin plate of the quality prescribed for roofing is better than galvanized iron.

For buildings covered with a prepared or built-up roofing the gutters can, if prepared with the proper care, give good results if formed in the roof and of the same material as the roofing.

Hanging gutters are frequently made of considerable length and must be strongly built, as otherwise they are liable to deflect from a uniform grade. They should be placed below the plane of the room to avoid damage by sliding snow.

Flashing.—Saturated felt, properly coated with good asphalt or pitch preparations, will ordinarily give better results than metallic flashings for buildings subjected to gases and fumes. The metallic flashings are ordinarily suitable on a building not exposed to gases. The importance of the thorough construction of flashings and work around openings cannot be overestimated and the subject deserves a thorough discussion.

Fire Protection.

What should be one of the most important considerations in the selection of roofing is its fire-resisting qualities, especially if the building be where it can be exposed to fire from adjacent structures. A roofing should, as far as possible, protect the structure from danger due to surrounding fires.

In congested districts a flat roof will have better fire-resisting value than a steeper one, as it is not so easily attacked by the flames and radiant heat, though it would afford a better resting place for flying brands. In large fires trouble frequently results with some types from the roofing being loosened about the edges, allowing it to curl up and the flames to get at the material underneath. Care should be taken to prevent this.

Conclusions.

The annoyance and indirect expense occasioned by leaky and short-lived roofs are rarely compensated for by any possible saving in first cost.

In selecting a roofing there should be considered:

(1) Chance of leaks due to character of construction.
(2) Probable life, including chance of damage by the elements and by wear from other causes.
(3) Fire-resisting value.
(4) Cost of maintenance.
(5) Cost of materials.
(6) Cost of laying.

The ordinary practice of depending merely upon guarantees in selecting roofings cannot be trusted to secure proper results.

Where proper materials and the requisite skill in application are available, built-up roofs of coal-tar felt, coal-tar pitch and gravel or slag are recommended for roofs with a pitch of two inches or less to the foot.

Where the roof is to be subjected to wear and where the character of the construction warrants the expense, flat tiles or brick should be used as a protective coating to the roofing instead of gravel or slag.

As a general proposition railroad buildings should be designed to accommodate this type to allow it to be used, and because of economy in construction and of decreased fire hazard. A pitch of from one-half to one inch to the foot is better than anything steeper. Nothing but straight-run pitch should be used.

No contracts should be made for a built-up roof without a complete and positive specification including flashings, and the contract prices should not be less than those of the materials specified, plus a reasonable amount to cover the cost of laying and profit. Thorough inspection of workmanship and material is recommended.

For slopes of from two to six inches to the foot fair results can be expected if the top coating of pitch be especially prepared. This can be successfully done only by skilled workmen, who are also necessary for its application. Especial care must also be taken in the selection and application of the stone or slag coating.

Asphaltic compounds have value for a built-up roof for the top coating on slopes of from two to six inches to the foot. They may also be desirable at points where good coal-tar cannot be obtained, except at a cost appreciably greater. They should not be used except where they can be obtained from reputable dealers with complete information as to their constituents and where they can be applied by men skilled in their use.

Ready or prepared roofings are recommended for use on small, temporary and other buildings, where the cost, considering maintenance, of more expensive roofings, is not justified. They are of value for steep slopes where a built-up coal-tar roof cannot be used, and for locations where the skilled labor necessary for a built-up roof is not available. The steeper the slope the greater their relative value and the wider their economical field. The heaviest varieties are, in general, the more desirable because of their chance for longer life and their greater fire-resisting value. In making selections the reliability of the manufacturer, service tests and the cost should be governing factors.

In the laying of built-up and prepared roofings thoroughness in the preparation of flashings and work around openings is of vital importance.

Slate and tile of suitable quality, properly protected and fastened, can be recommended on roofs with a pitch of six inches to the foot or over, where expense is not the governing feature, and where they aid in producing the desired architectural effect, except that, where there is much chance of driving snow, eight inches to the foot should be the flattest slope allowed.

Wood shingles, except in isolated locations where there is small danger from sparks, should not be used.

Steel or impure iron materials should be avoided, no matter how protected.

The report is signed by O. P. Chamberlain (C. & I. W.), chairman; Maurice Coburn (Vandalia), vice-chairman; George W. Andrews (B. & O.), J. P. Canty (B. & M.), D. R. Collin, (N. Y. C.), H. M. Cryder, Wm. T. Dorrance (N. Y. C.), C. H. Fake (M. R. & B. T.), P. F. Gentine (M. P.), E. N. Layfield (B. & O. C. T.), M. A. Long (B. & O.), John S. Metcalf, Civil Engineer, H. Rettinghouse (C. & N-W.), C. W. Richey (P. R. R.)

Discussion on Buildings.

Mr. Lindsay: The committee has recommended the built-up roof of coal tar for pitch of two inches or less to the foot, and has permitted the use of asphalt only for an outer covering, in pitches of more than two inches. Is this association prepared to limit itself to the use of coal tar exclusively for roofing?

Mr. Coburn: We say that asphaltum compounds are valuable on the steep slopes. "They may also be desirable at points where good coal tar cannot be obtained except at a cost appreciably greater." We don't say they are not good on flat slopes. We do say coal tar is better under ordinary conditions.

A motion to adopt the recommendations was carried.

ROADWAY.

Subjects assigned were as follows:

(1) Consider revision of the Manual.

(2) Collect all known formulae for determination of size of waterways and tabulate them in such manner that they may be intelligently compared. Also consider whether, by the introduction of factors suiting local conditions, a general formula for waterways could not be used in all cases.

(3) Unit pressures allowable on the roadbed of different materials.

(4) Tunnel construction and ventilation.

(5) Investigate and report on the question of agricultural drainage in levee and marsh districts as they affect railways: (a) Laws and assessments. (b) Methods of construction of drainage channels through railways.

(6) Make concise recommendations for next year's work.

Sub-committees were appointed as follows:

(1) Revision of Manual: S. B. Fisher, chairman; Duncan MacPherson, J. R. W. Ambrose, H. J. Slifer.

(2) Formula for Waterways: W. D. Pence, chairman; John C. Beye, J. A. Spielmann.

(3) Unit Pressures on Roadbed: W. M. Dawley, chairman; Moses Burpee, J. G. Sullivan, Walt Dennis.

(4) Tunnel Construction and Ventilation: J. E. Willoughby, chairman; D. J. Brumley, C. Dougherty, W. P. Wiltsee.

(5) Drainage Districts: W. C. Curd, chairman; R. C. Young, Paul Didier, J. C. Sesser.

(6) Recommendations for 1911: The entire roadway committee.

Size of Waterways.

Acting under substantially the same instructions during the previous year, the sub-committee charged with this matter compiled a large amount of valuable material much of it then freshly gathered from the members of the association, relating to current practice in connection with fixing the size of waterways. As a result of the studies made up to that time the roadway committee submitted to the annual convention in March, 1909, the following preliminary or tentative conclusions which were adopted by the association:

"(1) In determining the size of a given waterway, careful consideration should be given to local conditions, including flood height and flow, size and behavior of other openings in the vicinity carrying the same stream, characteristics of the channel and of the watershed area, climatic conditions, extent and character of traffic on the given line of road and probable consequences of interruptions to same, and any other elements likely to affect the safety or economy of the culvert or opening.

"(2) (a) The practice of using a formula to assist in fixing the proper size of the waterway in a given case is warranted to the extent that the formula and the values of the terms substituted are known to fit local conditions.

"(b) Waterway formulae are also useful as a guide in fixing or verifying culvert areas where only a general information as to the local conditions is at hand.

"(c) The use of such formulae should not displace careful field observation and the exercise of intelligent judgment on the part of the engineer.

"(d) No single waterway formula can be recommended as fitting all conditions of practice."

The concluding paragraph (d) of the foregoing conclusions represented the practically unanimous opinion of the members of the roadway committee, but it seemed desirable in view of the widespread interest displayed in the inquiry that the matter should be the subject of some further study. To this end it was suggested to the board that the topic should again be assigned, and this was done.

The studies during the past year have taken the form of an extended library search made for the purpose of bringing together "all known formulae for determining the size of waterways" as nearly as practicable in conformity with the board's instructions. After some discussion, approval was given to the plan of undertaking these further compilations through the medium of a thesis investigation under the direction of Prof. W. D. Pence, chairman of the sub-committee having the investigation in charge. The results of their investigations, in somewhat condensed form, are submitted as Appendix A to the present report. The inquiry began with a general survey of the literature of the subject, and this was supplemented among other features by a critical examination into the merits of the so-called "Dunn Waterway Data" as a means of approach to the derivation of the general waterway formula contemplated in the board's instructions.

Although the matter thus brought together is lacking in completeness in certain of its aspects, the results were deemed worthy of preservation in permanent form as a progress report upon the subject, especially in view of the increasing interest displayed in this matter by engineers engaged both in the dimensioning of proposed new structures for carrying water through the roadbed and in defending their older structures under the fire of court attack.

The committee, after careful consideration of the results of its further investigations, although not prepared to modify the conclusions heretofore submitted to the Association that "no single waterway formula can be recommended as fitting all conditions of practice," nevertheless feels warranted in calling particular attention to certain relationships which give much promise in the direction of such general formula. The relationships referred to are best illustrated by introducing a graphical chart of the waterway data gathered by the late James Dunn in his exhaustive analysis of the practice of the Santa Fe system, covering many years' observation of the behavior of actual waterway openings under the widest possible range of conditions. The Dunn figures are reproduced in numerical form in Table 1, and graphically in Fig. 1, covering the remarkable sweep of watershed area ranging from 0.01 square mile (6.4 acres) to 6,500 square miles (4,000,000 acres), and of waterway areas from 2 square feet to upward of 15,000 square feet cross-section.

In attempting to reconcile the widely varying values of exponents applied to the values of watershed areas in the various formulae proposed for calculating culvert areas, it has been suggested in a previous report of this committee that the various authorities may have been dealing with run-off data observed from watershed areas of widely varying characteristics and shapes.

It should be stated that the committee has not, as yet, given more than casual consideration to the hydraulic features of the culvert proper. It is respectfully suggested that in the assignment of work for the coming year that phase of the subject be assigned to this committee for investigation, with liberty to report further progress, if any, with reference to the general waterway formula contemplated in the board's instructions for the past two years.

Conclusions.

(1) There is a general relationship between the best known waterway and run-off formulae. This relationship may be expressed by two terms, a varying coefficient and a varying exponent.

(2) The extent of this relationship for large and small areas is indicated by the Dunn waterway data, given in Fig. 1, and shown graphically by Fig. 2.

Drainage Districts.

The sub-committee dealing with this subject has made an exhaustive study of the laws of the various states and has compiled a complete list of the laws of Arkansas, Alabama, Arizona, Florida, Georgia, Virginia, Kentucky, Idaho, Maine, Texas, New Mexico, Tennessee, Mississippi, New York, Michigan, South Carolina and North Carolina.

The following states have no drainage laws in effect: Colorado, Connecticut, Massachusetts, New Hampshire, Rhode Island, Utah, Vermont and Wyoming.

As these laws are very voluminous, the committee decided not to publish them in the Proceedings until they have been abstracted, and the sub-committee is now making up a compilation with that portion of the laws which affects railroads. This we also hope to publish in a later bulletin.

Recommendations for 1911.

The committee would recommend continuing each of the subjects assigned for the past year, with the exception of sub-committee II—Formula for Waterways—and for this the committee would substitute the study of Hydraulic Features of Culverts and Waterways, to be continued as a supplement to the subject, Formula for Waterways.

The report is signed by: Geo. H. Bremner, C. B. & Q., chairman; S. B. Fisher, M. K. & T., vice-chairman; J. R. W. Ambrose, G. T.; John C. Beye, C. R. I. & P.; D. J. Brumley, I. C.; Moses Burpee, B. & A.; W. C. Curd, M. P.; W. M. Dawley, E. R. R.; Walt Dennis, K. C. S.; Paul Didier, B. & O.; C. Dougherty, C. N. O. & T. P.; Duncan MacPherson, N. T.; W. D. Pence, University of Wisconsin; John C. Sesser, G. N.; H. J. Slifer, C. G. W.; J. A. Spielman, B. & O.; J. G. Sullivan, C. P.; J. E. Willoughby, L. & N.; W. P. Wiltsee, N. & W.; R. C. Young, L. S. & I. & M.

Appendix A.

Waterway for Culverts.

This paper is a digest of the material compiled in the course of a thesis investigation by A. F. Gilman and G. W. Chamberlin in 1909-1910, under the direction of Prof. W. D. Pence, University of Wisconsin.

The following compilation of formulas for culvert areas and for the determination of run-off is believed to include all the better known formulas, besides several not customarily used by American railroad engineers. The nomenclature is taken without change from the original sources.

The Myers Formula:

$$A = c\sqrt{M},$$

where A = the area of waterway required, in square feet.
M = the area drained, in acres.
c = 1 as a minimum for flat country.
c = 1.6 for hilly compact ground.
c = 4.0 as a maximum for mountains, rocky country.

Major Myers recommended thise formula as applying well to the water courses which he had been able to examine, which lay chiefly on the line of the Richmond, Fredericksburg & Potomac Railroad.

The Talbot Formula:

$$A = c\sqrt[4]{M^3},$$

where A = the waterway area necessary, in square feet.
M = the area drained, in acres.

This formula is not intended for use for drainage areas of more than 400 square miles. It was derived with especial reference to areas under 77 square miles in size: "For rolling country subject to floods at a time of melting snow, and with a length of valley three or four times the width, let c be one-third. For valleys with stream longer in proportion to the area, decrease c. In districts not affected by accumulated snow and where the length of the valley is several times the width, one-fifth or one-sixth or even less may be used. For steep side slopes, especially where the upper part of the valley has a much greater fall than the channel at the culvert, c should be increased."

This formula is used very generally in the southwestern and western portion of this country and appears to give excellent results for the smaller areas.

The Peck Formula (better known as the Missouri-Pacific Formula):

$$\text{Area of waterway in square feet} = \frac{\text{Drainage area in acres}}{c}$$

c varies from 4 to 6, depending on the country.

In very mountainous country, where slopes of hills and mountains are steep and abrupt, c is equal to 4. In ordinary flat, rolling country, such as is found in good agricultural sections, c is equal to 6.

The Wentworth Formula:

$$a = d^{2/3},$$

where a = the sectional area of the waterway, in square feet.
d = the drainage area, in acres.

This formula was derived in connection with work on the Nor-

folk & Western Railway and is especially fitted to the conditions along that line, and in general to the conditions in the southeastern states. In cases of less rainfall, or if the ground be quite flat, the author states that the two-thirds power of the drainage area is too great for the square feet of area needed in the waterway. In the observations of Mr. Wentworth, 60 per cent of the resulting area may be taken as the lower limit.

The Murphy Formula:

$$A = \frac{Q}{V} = \frac{Q}{C\sqrt{RS}}$$

where A = area of waterway, in square feet.
V = mean velocity, in feet, per second.
R = hydraulic radius = range in stage in time of flood. (See explanation below.)

$$c = \frac{a + \frac{b}{n} + \frac{c}{S}}{1 + \left(a + \frac{c}{S}\right)\frac{n}{\sqrt{R}}}$$

where a, b and c are constants and n is the coefficient of roughness of the bed.

S = slope of surface.

"It can be shown that the hydraulic radius

$$R = \frac{A}{P} = \left(\frac{(I + 2\,d)\,X}{(I + 2\,d)\sqrt{(1 + X^2)}\,½}\right)d \ldots\ldots\ldots\ldots (3)$$

in which I is the bottom width of a trapezoidal section, d is the depth and X is the slope of the sides. It can be seen from equation (3) that for any given values of d and X.) R approaches d as I increases; for the case of floods, therefore, it may be assumed that R = the difference in stage between high and ordinary low water."

"This method of finding the waterway at a given place on a stream consists in finding the drainage area in square miles above the place under consideration, the greatest change in stage of the stream at this place and the slope of the surface. By multiplying the drainage area M by q (the maximum discharge in second-feet per square mile that is to be expected in that portion of the country), we find Q; dividing Q by V, using for R the maximum range of stage, and for S the measured slope of surface of the stream, we have the necessary area of waterway. The greatest error in the use of this method will result from an incorrect measurement of the slope. The formula calls for the slope of surface, and surface slope of a stream is not necessarily the slope of the bed. The slope is not the same at all stages, nor always the same for a given stage. If the place under consideration is near the mouth of a large tributary the slope of the main stream will be affected by the stage of the tributary. Overflow and flooding of lowlands is frequently the result of backwater, due to reduction of surface slope. The smaller the slope used the greater will be the computed waterway. If there is a possibility of the waterway becoming partly clogged with drift, logs or ice, or its being in the influence of backwater from a tributary, the computed area must be increased by a liberal amount."

Areas Drained in Square Miles. (1)	Areas of Waterway. Missouri and Kansas. (2)	Cast Pipe. Banks over 15 ft. Use 80 per Cent. (3)	Box and Arch Culverts. 1st Fig.—Diam. 2d. Fig.—Bench (4)	Percentage of Column 2. Illinois. (5)	Indian Territory. (6)	Texas. (7)	New Mexico. (8)	Areas Drained in Square Miles. (1)	Areas of Waterway. Missouri and Kansas. (2)	Percentage of Column 2. Illinois. (5)	Indian Territory. (6)	Texas. (7)	New Mexico. (8)
.01	2.0	1-24 in.	2x1 B	East of Streator use 60 per cent.	South of Purcell use Texas Column.	Use Column 2.	Use Column 2.	24	1,060	East of Streator use 60 per cent.	South of Purcell use Texas Column.	110	94
.02	4.0	1-24 "	2x2 "					26	1,100			110	93
.03	6.0	1-30 "	2x3 "					28	1,140			110	92
.04	7.5	1-36 "	2½x3 "					30	1,180			110	92
.05	9.0	1-42 "	3 x3 "					32	1,220			110	92
.06	10.5	1-42 "	3½x3 "					34	1,255			110	92
.07	12.0	1-48 "	3 x4 "					36	1,290			110	91
.08	13.5	2-36 " D	2½x3 "					38	1,320			110	91
.09	15	2-36 " "	2¾x3 "					40	1,350			110	91
.10	16	2-36 " "	3 x3 "					45	1,435			110	91
.15	25	2-48 " "	3 x4 "					50	1,510			110	89½
.20	32	3-42 "	6 x4 A					55	1,580			115	89½
.25	38	3-48 "	6 x5 "					60	1,650			115	89½
.30	44		6 x5½ "					65	1,720			115	88
.35	51		8 x4½ "					70	1,780			115	88
.40	56		8 x5 "					75	1,840			115	88
.45	62		8 x6 "					80	1,900			115	86½
.50	66		8 x6 "					85	1,960			115	86½
.55	70		8 x6½ "					90	2,015			115	86½
.60	74		10 x4½ "					95	2,085			115	86½
.65	78		10 x5 "					100	2,120			120	85
.70	81		10 x5½ "					110	2,220			120	85
.75	85		10 x6 "					120	2,315			120	85
.80	88		10 x6½ "					130	2,405			125	83½
.85	91		10 x6½ "					140	2,500			125	83½
.90	94		10 x6½ "					150	2,580			130	82
.95	97		12 x5 "					160	2,665			130	82
1.0	100		12 x5 "	West of Streator use 80 per cent.	North of Purcell use Column 2.		98½	170	2,745	West of Streator use 80 per cent.	North of Purcell use Column 2.	130	80½
1.1	110		12 x6 "			105	98½	180	2,820			130	80½
1.2	120		12 x7 "			105	98½	190	2,900			130	79
1.3	130		12 x8 "			105	98½	200	2,970			130	79
1.4	140		14 x6½ "			105	98½	220	3,115			130	77½
1.5	150		14 x7 "			105	98½	240	3,245			130	77½
1.6	160		16 x6½ "			105	98½	260	3,370			130	76
1.7	170		16 x7 "			105	98½	280	3,495			130	76
1.8	180		16 x7½ "			105	98½	300	3,615			130	74½
1.9	190		16 x8 "			105	98½	325	3,770			130	74½
2.0	200		18 x7 "			105	98½	350	3,900			130	73
2.2	220		18 x8 "			105	98½	375	4,035			130	73
2.4	240		18 x9½ "			105	98½	400	4,165			130	71½
2.6	260		20 x8 "			105	98½	450	4,385			130	70
2.8	280		20 x9 "			105	98½	500	4,610			130	68½
3.0	300		20 x9½ "			105	98½	550	4,825			130	67
3.2	321		22 x8½ "			105	98½	600	5,030			130	65½
3.4	340		22 x9 "			105	98½	650	5,230			130	64
3.6	357		24 x8½ "			105	98½	700	5,420			130	62½
3.8	373		24 x9 "			105	98½	750	5,610			130	61
4.0	388		28 x7 "			105	97	800	5,800			130	59½
4.2	403		28 x7½ "			105	97	850	5,990			130	58
4.4	417		28 x8 "			105	97	900	6,080			130	56½
4.6	430		28 x8½ "			105	97	950	6,230			130	
4.8	443		28 x9 "			105	97	1,000	6,380			130	
5.0	455		28 x9½ "	West of Streator use 80 per cent. East of Streator use 60 per cent.	North of Purcell use Column 2. South of Purcell use Texas Column.	105	97	1,100	6,705	West of Streator use 80 per cent. East of Streator use 60 per cent.	North of Purcell use Column 2. South of Purcell use Texas Column.	130	
5.5	483		28 x10 "			105	97	1,200	6,960			130	
6.0	509		32 x7½ "			105	97	1,300	7,230			130	
6.5	533		32 x8 "			105	97	1,400	7,480			130	
7.0	556		32 x9 "			105	97	1,500	7,725			130	
7.5	579		32 x10 "			105	97	1,600	7,960			130	
8.0	601		32 x11 "			105	97	1,700	8,195			130	
8.5	622		32 x11½ "			105	97	1,800	8,390			130	
9.0	641		32 x12 "			105	93½	1,900	8,625			130	
9.5	660		32 x12½ "			105	93½	2,000	8,820			130	
10	679		32 x13 "			105	93½	2,200	9,240			130	
11	710		Bridges designed to provide area according to circumstances.			105	93½	2,400	9,605			130	
12	740					105	93½	2,600	9,970			130	
13	775					105	93½	2,800	10,320			130	
14	805					105	93½	3,000	10,640			130	
15	835					105	93½	3,500	11,445			130	
16	865					105	94	4,000	12,160			130	
17	890					105	94	4,500	12,825			130	
18	920					105	94	5,000	13,500			130	
19	945					105	94	5,500	14,080			130	
20	970					105	94	6,000	14,620			130	
22	1,015					105	94	6,500	15,140			130	

Dunn's Waterway Table.

The Dunn Data:

A reproduction of the 1906 table may be found in the accompanying Table I. This data was derived principally from observations made along the lines of the Santa Fe Railway in Missouri, Kansas, Indian Territory and Texas.

The C., B. & Q. Formula:

$$Q = \frac{3000\ M}{3 + 2\sqrt{M}}, \text{ or using } V = 10 \text{ ft. per second,}$$

$$A = \frac{300\ M}{3 + 2\sqrt{M}}$$

where Q = the total discharge from the area in cubic feet per second.
M = the drainage area, in square miles.
A = the waterway in square feet, using the velocity through the culvert as 10 ft. per second.

The Cooley Formula:
No. 1. $Q = 200\ M^{2/3}$, or $A = 20\ M^{2/3}$.
No. 2. $Q = 180\ M^{2/3}$, or $A = 18\ M^{2/3}$.
Notation is the same as for C., B. & Q. formula.

The Tidewater (Virginia) Railway Formula:

$$A = 0.62\ M^{7-10}$$

where M = area drained (watershed) in acres.
A = Neat area of waterways, in square feet.

"Where the stream has a flat fall, add 30 per cent; where double openings are used, add 20 per cent total cross-section area."

The El Paso & South Western Railway Formula:

$$Q = 12\sqrt{\frac{8000}{A}}$$

where Q = the maximum run-off per square mile of drainage area.
A = the total drainage area in square miles.

This is practically the formula by Mr. Joseph P. Frizell, which he worked up from the records of flow over the Holyoke dam, Massachusetts, for a period of 50 years, and it appears in the original form in his book on hydraulics.

The Lauterberg Formula:

$$\text{Average discharge of a river} = \phi = \frac{1{,}000{,}000}{31{,}530{,}000}\ ChF = 0.03171\ ChF$$

where ϕ = average quantity discharged per second.
F = the area drained in square kilometers.
h = the total yearly rainfall in inches.
c = 0.20 for marshy soil.
= 0.25 for level plains.
= 0.30 for rolling ground.
= 0.35 for low hills.
= 0.45 for hilly country like the Ardennes, the Odenwald and the Eifel.
= 0.55 for the Black Forest and the Vosges.
= 0.70 for high rocky mountains.

Lauterberg endeavored to frame a rational estimate as to the probable discharge of streams by means of the above formula, which is based upon data collected in Switzerland.

The Fanning Formula:

$$Q = 200\ M^{5-6}$$

where M is the area of watershed in square miles and
Q is the volume of discharge in cubic feet per second.

The Dredge Formula:

$$Q = 1300\ \frac{M}{L^{2/3}}$$

Notation the same as in the Fanning formula.
L = the length of drainage area in miles.

The Dickens Formula:

$$Q = c \times 27\ M^{1/2}.$$

$Q = 200\ M^{3/4}$, for Madras Presidency, India.
$Q = 500\ M^{3/4}$, for Central Provinces, India.
$Q = 825\ M^{3/4}$, for Bengal and Bahar, India.
$Q = 1{,}200\ M^{3/4}$, for Upper Kaveri, India.
$Q = 2{,}200\ M^{3/4}$, for Gadamatti, India.

The O'Connell Formula:

$$Q = 458\left[\sqrt{(640\ M + 4.58)} - 45.8\right].$$

This formula is best adapted to small districts.
The notation is the same as that of the Fanning formula.

The Kutter Formula (derived by Ganguillet and Kutter in 1869):

$$Q = \frac{1421\ M}{0.311 + \sqrt{M}}$$

This formula is adapted to Swiss streams. The notation is the same as that of the Fanning formula.

The Hering Formula.

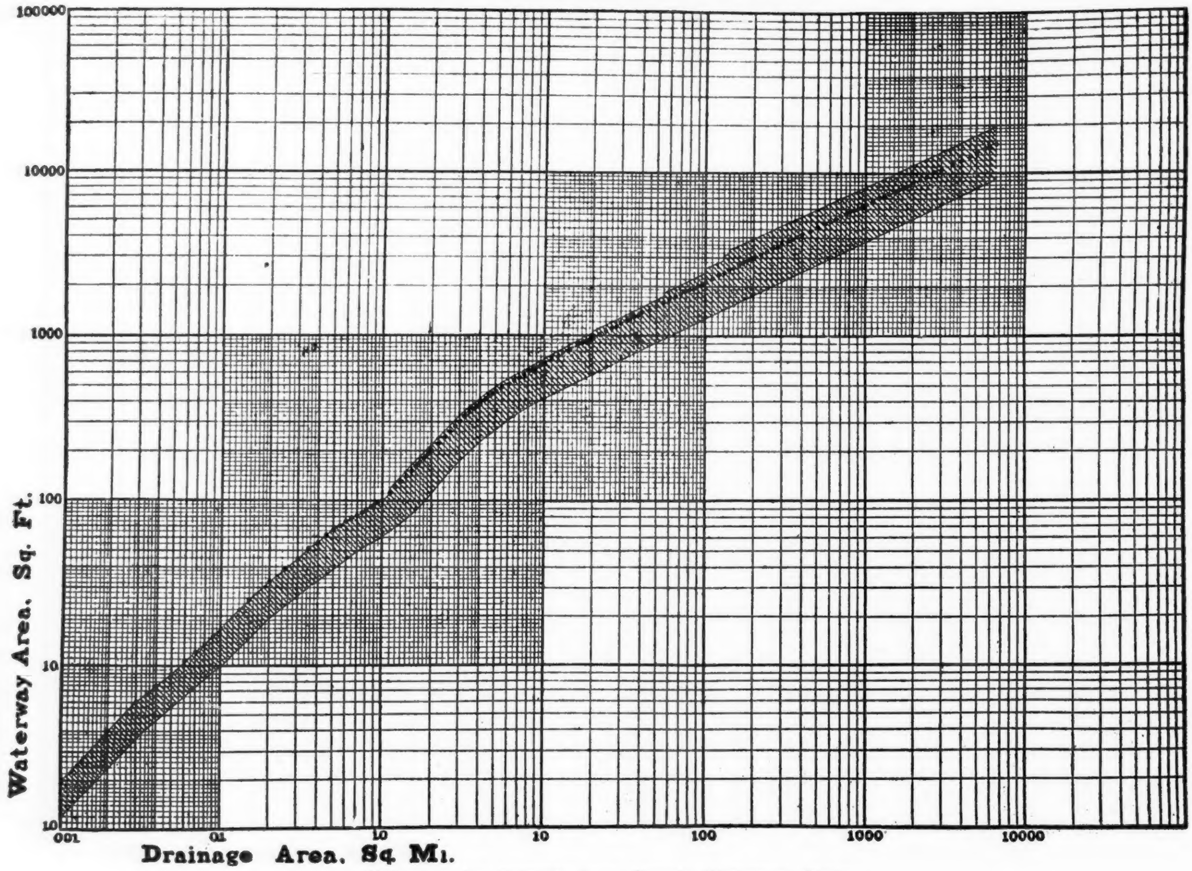
$$Q = \frac{D\ M\ v}{L} \text{ or } \frac{D\ M\ v}{t_1}$$

where Q and M are the same as those of the Fanning formula and
L = the length of the river.
v = the mean velocity of the stream.
D = the entire depth of rain flowing off during a storm.
t_1 = the time taken for a drop of water falling near the periphery of watershed to reach the culvert.

The Possenti Formula.

$$Q = c_2\,\frac{R}{L_1}\left(M_2 + \frac{M_1}{3}\right)$$

c_2 = a coefficient with an average value of 1,010.
R_2 = the depth of rainfall in inches for 24 hours.
M_2 = the area of hilly or mountainous part of watershed, in square miles.



Waterway for Culverts from Dunn's Waterway Table.

M_1 = the area of level or flat part of watershed, in square miles.
L_1 = the length in miles of the stream from its source to the point of observation.

This formula applies especially to mountain streams of moderate size in the Apennines.

The Burkli-Ziegler Formula.

$$q = c\, r \sqrt[4]{s/a}$$

where q = the water reaching the sewer in cubic feet per acre per second
r = the average intensity of rain during heaviest fall in cubic feet per acre per second.
s = the general grade of the drainage area in feet per hundred.
a = the area drained, in acres.
c = a coefficient, for average areas it equals 0.625.

The observations extended up to slopes of 10 ft. per 100, but were limited to small areas of less than 50 acres. This formula is especially applicable to sewer design.

The Coghland Formula.

$$P = t\ c\ R^{1.9}$$

where P=the inches of rainfall discharged by steam.
t=a coefficient for time, the value of which is governed by the length of time the freshet lasts.
c=a coefficient of rainfall varying with the quantity of rain.
R=the average daily rainfall in inches during the freshet.

This formula is applicable to drainage districts of moderate size in New South Wales.

The following values of t and c are given by the author:

Length of freshet in days...350	Value of t in inches.........2.6
Length of freshet in days...300	Value of t in inches.........2.5
Length of freshet in days...250	Value of t in inches.........2.4
Length of freshet in days...200	Value of t in inches.........2.2
Length of freshet in days...150	Value of t in inches.........2.1
Length of freshet in days...100	Value of t in inches.........2.0
Length of freshet in days... 50	Value of t in inches.........1.9
Length of freshet in days... 25	Value of t in inches.........1.8
Rainfall in inches........... 0.40	Value of c in inches.........0.95
Rainfall in inches........... 0.35	Value of c in inches.........0.90
Rainfall in inches........... 0.30	Value of c in inches.........0.85
Rainfall in inches........... 0.25	Value of c in inches.........0.80
Rainfall in inches........... 0.20	Value of c in inches.........0.75
Rainfall in inches........... 0.15	Value of c in inches.........0.70
Rainfall in inches........... 0.10	Value of c in inches.........0.65

The Craig Formula.

$$Q = 440 \times B \times N \text{ hyp. log} \frac{8\,L^2}{B}$$

where Q = the total discharge in cubic feet per second.
N = c v i, where v = the velocity toward the culvert in feet per second.
i = the number of inches of rainfall.
c = the coefficient of discharge.
L = the extreme length of the drainage area.
D = the mean width of the drainage area.

The McMath Formula.

$$Q = c\, v \sqrt[5]{S\, A^4} = A\, c\, v \sqrt[5]{s/A}$$

where c = the proportion of rainfall that reaches sewers.
v = the number of cubic feet of water falling upon an acre of surface per second during the period of greatest intensity of rain. It is practically the same as the rate in inches per hour.
s = the mean surface grade in feet per thousand.
A = the area drained in acres.
Q = the discharge in cubic feet per second.

This formula was derived with especial reference to St. Louis conditions.

The Chamier Formula.

$$Q = 640 \times R \times C \times M^{3/4}$$

where Q = the discharge in cubic feet per second.
R = the average rate of the greatest rainfall anticipated in inches per hour for such duration as will allow the food flood water flowing to the outlet from the farthest extremity of the catchment area.
c = a coefficient of surface discharge, giving the proportion of rainfall that may be expected to flow off the surface.

The above formula has been tested by Mr. Chamier on streams in India having drainage areas of from 20 acres to 400 square miles.

The Cramer Formula.

$$Q = \frac{c_3\, R_3\, m\, M\, (S_2)^{1/3}}{9 + (0.0658\, m\, R_2\, M)^{1/3}}$$

where Q = the discharge in cubic feet per second.
R_2 = the mean annual rainfall in inches.
$S_2 = \frac{e_1 + e_2}{l}$ = the mean slope and declivity of the whole basin; e_1 being its average altitude in feet, e_2 being the altitude of the point of discharge, and l being the average distance in feet traveled by the water from the boundaries of the watershed to the point of measurement.
c_3 = a variable coefficient.
= 186 for rough natural basins of rivers.
= 697 for smooth, comparatively level and impervious areas like well-built cities.
m depends on the total area M, the flat area F, which is likely to be inundated in freshets, and the mean annual rainfall R_3, such relation being expressed by:

$$m = 1 - \sin\left(-\tan^1 \frac{709\,F}{M\,R_3}\right)$$ for the simple case when F is distributed in an approximately uniform manner throughout the whole basin, whereas if F is concentrated only at the lower end of the basin, we must place

$$m = 1 - \sin\left(-\tan^1 \frac{1418\,F}{M\,R_3}\right)$$

The Italian Formulas

$$Q = \frac{1819\ M}{0.311 + \sqrt{M}} \quad (1)$$

$$Q = \frac{2600\ M}{0.311 + \sqrt{M}} \quad (2)$$

The notation in these formulas is the same as that of the Fanning formula. No. 1 is applicable to streams in northern Italy, and No. 2 to small brooks in the same region.

The Kuichling Formulas.

$$q = \frac{44{,}000}{M + 170} + 20 \quad (1)$$

$$q = \frac{127{,}000}{M + 370} + 7.4 \quad (2)$$

Here q = the discharge in second-feet per square mile, and M = the drainage area in square miles. These equations were derived from conditions similar to those in the valley of the Mohawk river. They were obtained from a great amount of flood data on both American and European streams. Equation No. 1 gives the discharge during floods which may occur occasionally. Equation No. 2 gives the discharge during floods that occur but rarely.

The Murphy Formula.

$$q = \frac{46{,}790}{M + 320} + 15$$

The notation here is the same as that of the Kuichling formulas. This equation was derived from a large amount of flood data on streams of the northeastern United States which Mr. Murphy had collected.

The Gray Formula.

$$Q = 5.89\ A^{3/4}$$

where Q = the discharge in second-feet per acre, and
A = the drainage area in square miles.

In his discussion of logarithmic diagram of the Dunn data, Prof. W. D. Pence found that by drawing tangents to the curve at various points the exponents of the equations of these tangents varied from unity for very small areas to one-half for the largest areas drained. This is a very interesting discovery, and it may be that it represents the law for which engineers have been continually looking, but without further verification of the Dunn figures it is impossible to draw any final conclusion in regard to the matter.

Discussion on Roadway.

Mr. Churchill: I believe there should be an investigation all over the United States with a view to finding a general waterway formula by which a change in the coefficient will be applicable to the different sections, and I believe that this committee is in better shape to take up such a formula than any other body in the United States.

Prof. Pence: If the members of the association will support the committee by responding to the circular which the committee plans to send out, by platting a few points on the diagram, it is believed that considerable progress can be made.

A motion to receive the report as information was carried.

RECORDS AND ACCOUNTS.

The Board of Direction assigned the following work:

(1) Recommend a form and system for keeping sidetrack records.
(2) Continue the study of estimate forms for construction and maintenance work.
(3) Consider revision of the Manual.
(4) Make concise recommendations for next year's work.

The following sub-committees were appointed:

Sidetrack Records: M. C. Byers, chairman; C. W. Pifer, Thomas Maney.

Bridge Estimate Forms: Edward Gray, chairman; R. W. Willis, E. E. Hanna.

Building Estimate Forms: W. H. Sellew, chairman; J. H. Milburn.

Water Service Estimate Forms: C. H. Gerber, chairman; J. M. Brown.

Section Foremen's Material Report: Henry Lehn, chairman; J. E. Turk, T. H. Gatlin.

Sidetrack Records.

The work outlined for this sub-committee was as follows:

(1) To collect data in the nature of forms and methods used by railroads for keeping sidetrack records. (2) To formulate a definite recommendation for a method of preparing and keeping such records, with particular attention to the following features: (1) Reporting completion of sidetracks. (2) Keeping permanent record of same. (3) Periodically checking location and length to insure the record always being correct.

The information considered desirable for such a record generally consists of the following: Location of sidetrack by mile post and station; length; alinement; gradient; actual cost, and by whom assumed; character, age and weight of rail; character and size of ties; description of bridges and culverts; date of construction; memorandum of agreement, if any, covering construction and maintenance; title to property occupied.

The investigation developed that the railway companies have not as a general thing devised very complete systems for keeping sidetrack records, although the necessity for such is generally admitted, but not fully appreciated. There would seem to be no reason why the same care should not be given to maintaining careful records of sidetracks as is given to keeping records of main tracks and other physical assets of a railroad company.

In the analysis of the subject the sub-committee came to the conclusion that a sidetrack record should be used for the following reasons:

(1) To provide data for compiling reports to state railway commissions and the Interstate Commerce Commission. (2) To provide data for annual reports. (3) Keep a record of ownership of sidetracks. (4) Keep records for taxation purposes. (5) Provide a convenient method by which the officers of a railway in direct charge of maintenance or changing of sidetracks may become familiar with the conditions under which the tracks are constructed and maintained. This is especially valuable in connection with sidetracks which are owned wholly or in part by private parties or corporations, the maintenance of which is performed by the railroad company and the cost charged against the owner.

Failure to keep accurate sidetrack records has resulted in much controversy between interested parties and oftentimes endless search through correspondence files in order to develop the information which ought to be readily found and for which there is constant call. In a large percentage of industrial tracks there are other than railway interests. The title to the track and property and maintenance of same makes it just as important to keep a complete and accurate record, which should supplement the written contracts, as to keep records of titled property. In addition, there is necessity for keeping better records on account of constantly increasing demands of local and national authorities for data in connection with physical condition of property, for which reliable records must be within easy reach. It is felt that the importance of this feature of railroad records cannot be too greatly emphasized and that it has not heretofore been given the prominence it deserves.

The committee presents to the association for adoption the form proposed for sidetrack records.

The general scheme of the form is to have a permanent record, which will be corrected annually, and which will, as far as possible, show accurately the track situation at all times, and it is so planned as to permit additions or reductions in length to be indicated immediately upon completion of the work without causing the form to be rewritten.

The form needs very little explanation, as the headings of the columns show exactly what information is to be recorded. In presenting this form the committee has in mind the necessity for a form that will fit all conditions, and this accounts for four or five columns which show in different methods the location of track, as the same method for indicating the location could not be used under all conditions.

It is proposed that this form be printed on tracing cloth, so that as many copies as are desired can be taken from it by blueprinting, the original to be retained in the local office. At the end of the year or other prescribed period, the local officers should correct the report and send new prints to the office of the chief engineer or whatever general officers may require such information.

In detailed explanation of the use of the columns the following instructions are proposed to accompany this form:

Column No. 1. Show location of sidetracks referred to mile posts, which method would be used for tracks which are not a part of yards or within station limits. In such cases the mile post location will be the mile and plus of the switch nearest the mile post measured in the direction in which the mileage is carried.

Column No. 2. Give reference indicating that the sidetrack is on the right or left side of the main track.

Column No. 3. Give name of station at which track is located.

Column No. 4. Give name of county and state.

Column No. 5. Give name or number of township or school district.

Column No. 6. Give name or number of track, as it may be designated.

Column No. 7. Indicate whether the track is a spur or connected at both ends.

Column No. 8. Show construction authority number.

Column No. 9. Give number of contract, if any exists, covering construction, operation or maintenance.

Column No. 10. Show date side track was completed.

Column No. 11. Give character, age and weight of rail.

Columns Nos. 12, 13, 14 and 15. Show actual length of track at the end of prescribed record year, dividing the ownership between the railway and outside interests.

Columns Nos. 16, 17, 18 and 19. Show changes which may be made to track during the record period. In these columns the plus sign should be used to indicate track length which is added, and the minus sign should be used for track length which is taken up.

Column No. 20. Show any miscellaneous information that has a bearing upon the track and which is not provided for by separate column.

A space should be provided between the various stations to permit of additional side tracks being recorded without making a new sheet.

All totals and all figures indicating changes during the year should be shown on the tracing paper in pencil, also the last two figures of the year in which the report is made, but all other figures should be made with India ink. The local officers preparing the side track record should retain the original form and at the end of the period for which the report is to be made, should, after correcting their previous reports to date, send the necessary sets of blue prints to the office of the chief engineer, one for use until a new report is made, and the others to be filed as a permanent record. The tracing paper form should not be used for reference, but be filed in a dust-poof box until it is necessary to correct it or make necessary blue print copies.

All tracks should be reported on the side track record in linear feet of track.

In reporting weight of rail with which the original track was constructed, this should be reported as linear feet of track.

The committee recommends to the association for adoption in the Manual of Recommended Practice the proposed form for sidetrack record shown as Exhibit A.

Bridge Estimate Forms.

This sub-committee was instructed to continue the study of this subject, which was begun but not completed in the 1909 report, following the general idea of having a form which would provide a uniform method for making such estimates and furnishing a guide to the estimator to avoid errors of omission. They very soon determined that it would not be practicable to attempt to follow in the preparation of this form the scheme of printing the various items that enter into general bridge work. The character of construction varies too much to make such a plan feasible, and it was therefore concluded by the sub-committee, which conclusion was indorsed by the general committee, that in the design of such a form the front page should be left blank as far as the list of items is concerned, but that on the reverse side of the sheet

should appear a list of the principal items which enter into various kinds of bridge construction and which would be a guide to the estimator, and insure uniform arrangement of items in the estimates and prevent omission of important features.

In the preparation of this list of items it was found quite easy to include too much detail, and the committee has therefore not attempted to go beyond the principal items. The situation in regard to an estimate for bridge work which would fit all classes of structures is somewhat different from the preparation of a similar form for track estimates, but in the design of the face of this form an attempt has been made to make it consistent in arrangement with the form recommended and adopted for track estimates, with the exception of printing the details.

The instructions to sub-committees C and D were of the same general character as those given to sub-committee B, and forms of a similar design were presented.

Section Foreman's Material Report and Revision of the Manual.

The committee does not offer any suggestion or changes with reference to the general subject of revision of the Manual. The committee has been unable to do much more than complete the work on estimate forms and preparing side track record, and while some attempt was made to study several of the forms, particularly those applying to section foremen's material reports adopted by the association, nothing conclusive was determined in this direction.

The report is signed by: H. R. Safford (Edgar Allen American Manganese Steel Company), chairman; H. J. Pfeifer (Terminal Railroad Association), vice-chairman; J. M. Brown (C. R. I. & P.), M. C. Byers (St. L. & S. F.), T. H. Gatlin (Southern), C. H. Gerber (consulting engineer), Edward Gray (Southern), E. E. Hanna (M. P.), Henry Lehn (New York Central), Thos. Maney (L. & N.), J. H. Millburn (B. & O.), C. W. Pifer (Ill. Cent.), W. H. Sellew (Mich. Cent.), J. E. Turk (P. & R.), R. W. Willis (C. B. & Q.).

Discussion on Records and Accounts.

Mr. McDonald: I would like to ask the committee whether they gave consideration to the question of large yard groups. Is it the intention that each track in a group shall be placed on this blank, or are they to be treated as groups?

Mr. Safford: The idea was that a condition of that kind be handled as a group. You cannot individualize every track in a large yard.

Mr. Brooke: There is one omission that I would like to see taken care of. Nearly all private sidings are covered by an agreement, and this would be a convenient place for it.

Mr. Safford: Column 9 covers it. It should be contract number instead of "Construction number."

President: That will be corrected.

A motion to adopt the form was carried.

Mr. Kittredge: I would like to ask for some explanation of the item of "general expense," in the form for "water service estimated."

Mr. Safford: That was intended to mean a general heading for what might follow in the way of miscellaneous items that were not listed. The classification of the things that are ordinarily met in estimates of that kind appears in items 1 to 8. From that point on, it is miscellaneous that we did not feel like listing.

Mr. Kittredge: I was wondering why it did not appear in the other blanks.

Mr. Safford: It should have appeared in the others. That was an oversight.

The President: The committee will add that to the blanks in which it does not now appear.

Mr. Kittredge: Engineering and train service are grouped together in Article XIII, while in Article VI, the article "Train Service" is given again. Is there some special kind of engineering and train service covered?

Mr. Safford: That is another typographical error.

The President: "And train service" will be omitted.

Mr. Brooke: I suggest "Miscellaneous expense" be substituted for "General expense."

The President: That is acceptable to the committee.

A motion to adopt the form was carried.

UNIFORM GENERAL CONTRACT FORMS.

The committee was instructed to take up the following work:

(1) Review and revise uniform general contract forms presented at tenth annual convention.

(2) Make concise recommendations for next year's work.

The committee has thoroughly considered the report made at the 1909 convention, and published in Bulletin 108, and has made a study of the principal contracts in use. The plan of having an agreement form of two pages separate from the general contract conditions is approved by the committee, and the agreement form presented in that report has been reconsidered and revised and is presented herewith with recommendations for adoption.

In small or unimportant contracts this agreement form, which is designated as Form A, may be used alone, but in larger contracts the "General Conditions" statement designated as Form B may be inserted, using the agreement form as a folder with the introductory page at the beginning of the contract and the signatures at the end.

Specifications relating to the particular work can either be included in the folder or attached to the back.

The committee has, in the agreement, made the "Contractor" the party of the first part and the "Company" the party of the second part and has, therefore, in preparing the "General Conditions," placed the provisions relating especially to the duties and rights of the "Contractor" first and those relating to the duties and rights of the "Company" last.

The committee has outlined for future meetings the formation of the remaining sections, which, in general, will cover the following terms: Property and right of entry; temporary suspension of work; annulment; measurement and approval of work; estimates and payments.

Conclusions.

The committee especially presents for approval:

(1) The general scheme of having the two-page general agreement, Form A, as a folder within which the other portions of the contract can be bound, thus permitting a concise contract form or a large contract form, according to the requirements of the case.

(2) The agreement—Form A—as presented herewith:

The committee presents for discussion and suggestions:

(1) The scheme of arrangement of B—General Conditions.

(2) The composition of the 28 sections enumerated.

For next year's work it is recommended that preparation of a standard contract form be continued on the lines already begun.

The report is signed by: J. C. Irwin (Rutland R. R.), chairman; W. G. Brimson (Q., O. & K. C.), vice-chairman; E. F. Ackerman (L. V.); F. H. Alfred (C., H. & D.); Wm. Archer (B. & O. S.); William Ashton (O. S. L.); W. G. Atwood (L. E. & W.); W. L. Breckenridge (C. B. & Q.); E. H. Lee (C. & W. I.); F. W. Smith (C., C., C. & St. L.); W. F. Tye (Civil Engineer); C. A. Wilson (Consulting Engineer).

Construction Contract.

Agreement.

This agreement, made this .... day of .... in the year .... by and between .... party of the first part, hereinafter called the Contractor, and .... party of the second part, hereinafter called the Company.

WITNESSETH, That, in consideration of the covenants and agreements hereinafter mentioned, to be performed by the parties hereto and of the payments hereinafter agreed to be made, it is mutually agreed as follows:

The contractor will furnish all the necessary transportation, materials, superintendence, labor and equipment and will execute, construct and finish in an expeditious, substantial and workmanlike manner to the satisfaction and acceptance of the chief engineer of the company.

....

....

in accordance with the plans hereto attached or as hereinafter described and the following general conditions, requirements and specifications, forming part of this agreement.

The work covered by this contract shall be commenced .... and completed on or before the ....day of..................................191..........

....

....

And in consideration of the completion of the work described herein, and the fulfillment of all the stipulations of this agreement to the satisfaction and acceptance of the chief engineer of the company, the said company, its successors or assigns, hereby agree to well and truly pay, or cause to be paid, to said contractor, the executors, administrators, successors or assigns of said contractor, as the case may be, the amount due the contractor, based on the following prices ....

....

....

IN WITNESS WHEREOF, The parties hereto have duly executed this instrument in duplicate the day and year first above written.

WITNESS:

....

....

Construction Contract.

General Conditions.

1. Bond.—The Contractor agrees, at the time of the execution and delivery of this contract and before the taking effect of the same, to furnish and deliver to the Company a good and sufficient bond of indemnity to the amount of .... dollars, as security for the faithful performance, by the Contractor, of all the covenants and agreements on the part of the Contractor contained in this contract. The security in such bond of indemnity must be satisfactory and acceptable to the Company.

This bond shall remain in force and effect in such amount, not greater than that specified, as shall be determined by the Chief Engineer, until the final completion and acceptance of the work.

2. Contractor's Understanding.—It is understood and agreed that the Contractor has satisfied himself by careful personal examination as to the nature and location of the work, the form of the surface of the ground, the character, quality and quantity of the materials to be encountered, the character of the plant, structures, equipment and facilities needed preliminary to and during the prosecution of the work, the general and local conditions, and all other matters which can in any way influence this contract, and no information upon any such matters derived from the maps, plans, profiles, drawings or from any source whatever, shall in any way affect any risk or obligation, or relieve him from fulfilling any of the terms of this agreement. No verbal agreements or conversations with any officer, agent or employe of the Company, either before or after the execution of this contract, shall affect or modify any of the terms or obligations herein contained.

3. Intent of Plans and Specifications.—All work that may be called for in the specifications and not shown on the plans, or shown on the plans and not called for in the specifications, is to be executed and furnished by the Contractor as if described in both these ways; and should any work or material be required which is not denoted in the specifications or plans, either directly or indirectly, but which is nevertheless necessary for the proper carrying out of the intentions thereof, the Contractor is to understand the same to be implied and required, and is to perform all such work and furnish any such material as fully as if they were particularly delineated or described.

4. Permits.—The Contractor shall, at his own cost and expense, except as specifically provided in this contract, secure the necessary permits for the work included in this contract and will be responsible for violations of any laws, rules or regulations.

5. Protection.—Whenever the local conditions, laws or ordinances require, the Contractor shall furnish and maintain, at his own cost and expense, necessary passageways, guard fences and lights and such other facilities and means of protection as may be required.

6. Rights of Various Interests.—Whenever work being done by Company forces or by other Contractors is contiguous to work covered by this contract, the respective rights of the various interests involved shall be determined by the Engineer, to secure the completion of the various portions of the work in general harmony.

7. Consent to Transfer.—The Contractor agrees not to let or transfer this contract or any part thereof (except for the delivery of material) without consent of the Chief Engineer, given in writing. Such consent does not release or relieve the Contractor from any or all of his obligations and liabilities under this contract.

8. Superintendence.—The Contractor agrees to constantly super-

intend all the work embraced in this contract in person or by a duly authorized manager acceptable to the Company.

9. Timely Demand for Points and Instructions.—The Contractor shall not proceed until he has made previously timely demand upon the Engineer for, and received from him, such points and instructions as may be necessary as the work progresses. The work shall be done in strict conformity with such points and instructions.

10. Report Errors and Discrepancies.—If the Contractor, in the course of the work, finds any discrepancy between the plans and the physical conditions of the locality, or any errors in plans or in the layout as given by said points and instructions, it shall be his duty to immediately inform the Engineer. Any work done after such discovery, until verified, will be done at the Contractor's risk.

11. Preservation of Stakes.—The Contractor must carefully preserve bench marks, reference points and stakes, and in case of wilful or careless destruction he will be charged with the resulting expense and shall be responsible for any mistakes that may be caused by their unnecessary loss or disturbance.

12. Inspection.—All work and materials shall at all times be open to the inspection, acceptance or rejection of the Engineer or his duly authorized representative. The Contractor shall at all times provide sufficient, safe and proper facilities for such inspection.

13. Defective Work or Material.—Any omission or failure on the part of the Engineer to disapprove or reject any work or material shall not be construed to be an acceptance of any defective work or material. The Contractor shall remove, at his own expense, any work or material condemned by the Engineer, and shall rebuild and replace any work or material so condemned without extra charge, and in default thereof the same shall be done by the Company at the Contractor's expense—or in case the Chief Engineer should not consider the defect of sufficient importance to require the Contractor to rebuild or replace any imperfect work or material, he shall have power, and is herein authorized, to make any deduction from the stipulated price that he may see proper.

14. Indemnity.—The Contractor agrees to indemnify and save harmless the Company for and from all claims, demands, payments, suits, actions, recoveries and judgments of every nature and description brought or recovered against it, for or on account of any injuries or damages received or sustained by any party or parties by reasons of any act or omission of the said Contractor, his agents or employes, in the construction of said work or by or in consequence of any negligence or carelessness in guarding the same.

15. Settlement for Wages.—Whenever, in the opinion of the Chief Engineer, it may be necessary or conducive to the progress of the work to secure to any of the employes of the Contractor any wages which may then be due them, the Company is hereby authorized to pay such laborers the amount due them or any lesser amount, and the amounts so paid them, as shown by their receipts, shall be deducted from any moneys that may be or become payable to said Contractor.

16. Liens.—If at any time any one employed by the Contractor, either to perform work as a sub-contractor or laborer or otherwise, or to furnish any materials, shall file or give notice of any mechanic's or other liens therefor, the Company is hereby authorized to pay and discharge the same if it shall deem best so to do, and to deduct the amount so paid from any moneys which may be or become due and payable to the Contractor.

17. Work Adjacent to Railroad.—Whenever the work embraced in this contract is near the tracks, structures or buildings of this Company or of other railroads, the Contractor shall use extraordinary care and vigilance to avoid injury to persons or property. The work must be so conducted as not to interfere with the movement of trains or other operations of the railroad; and if in any case such interference be necessary, the Contractor shall not proceed until he has first obtained specific authority and directions therefor from the proper officer of the Railroad Company and has the approval of the Engineer.

18. Risk.—The work in every respect shall be at the risk of the Contractor until finished and accepted.

19. Order and Discipline.—The Contractor shall at all times enforce strict discipline and good order among his employes, and any employe of the Contractor who shall appear to be incompetent, disorderly or intemperate, or in any other way disqualified for or unfaithful to the work entrusted to him, shall be discharged immediately on the request of the Engineer, and he shall not again be employed on the work without the Engineer's written consent.

20. Contractor Not to Hire Company's Employes.—The Contractor shall not employ any of the Company's employes.

21. Intoxicating Liquors Prohibited.—The Contractor shall not permit the sale, distribution or use of any intoxicating liquors upon or adjacent to the work, or allow any such to be brought upon, to or near the line of the railway of the Company.

22. Cleaning Up.—The Contractor must, before the work is finally accepted, at his own expense, clear away from the Company's property and from all public and private property all temporary structures, rubbish and waste material resulting from his operations.

23. Engineer and Chief Engineer Defined.—Wherever in this contract the word Engineer is used, it shall be understood as referring to the Chief Engineer of the Company, acting personally or through an assistant duly authorized in writing for such act by the Chief Engineer, and wherever the words Chief Engineer are used it shall be understood as referring to the Chief Engineer in person, and not to any assistant engineer.

24. Power of Engineer.—The Engineer shall have full power to reject or condemn all work or material which, in his opinion, does not conform to this agreement; to direct the application of forces to any portion of the work which in his judgment requires it; to order the force increased or diminished, and to decide every question that may arise between the parties relative to the execution of the work.

25. Adjustment of Dispute.—All questions, differences or controversies which may arise between the Contractor and the Company, under or in reference to this agreement, or its performance or non-performance, or the work to which it relates or in any way whatever pertaining to or connected with said work, shall be subject to the decision of the Chief Engineer, and his decision shall be final and conclusive to both parties.

26. Order of Completion; Use of Completed Portions.—The Contractor shall complete any portion or portions of the work in such order of time as the Engineer may require. The Company shall have the right to take possession of and use any completed or partially completed portions of the work, notwithstanding the time for completing the entire work or such portions may not have expired; but such taking possession and use shall not be deemed an acceptance of the work so taken or used or any part thereof. If such prior use increases the cost of the work, the Contractor will be entitled to such extra compensation as the Chief Engineer may determine.

27. Changes.—The Company shall have the right to make any changes that may be hereafter determined upon, in the nature or dimensions of the work, either before or after its commencement, and such changes shall in no way affect or void this agreement, but the difference in the value of the work shall be adjusted by the Engineer. If such changes diminish the quantity or extent of the work to be done, they shall not, under any circumstances, be construed as constituting, and shall not constitute, a claim for damages or for anticipated profits on such work.

In case of any work being done under a lump-sum contract price, and the quantity of work actually furnished upon completion of the work should varry and prove more or less than the quantities shown on the original plans and provided for by the specifications, then the contract lump-sum price is to be adjusted in the final payment accordingly. If the contract provides a schedule of unit rates for variations in the work, then the adjustment is to be made on the basis of such unit rates, either adding or deducting the corresponding amounts according to whether the quantity of each class of work was increased or decreased over the amounts originally covered by the lump-sum bid; if the contract does not contain such a schedule of unit rates, then the value of all such additions or omissions is to be established by the Engineer, and the adjustment made accordingly.

28. Extra Work.—No bill or claim for extra work or material shall be allowed or paid, unless the doing of such extra work or the furnishing of such extra material shall have been authorized in writing by the Engineer, and the price to be paid fixed by the Chief Engineer in writing before any part of such work was done or material furnished.

The Chief Engineer, in fixing the price for the doing of work or the finishing of material not provided for in this agreement, may either fix a unit price or a lump-sum price or may, if he so elects, provide that the price shall be determined by the actual cost, to which shall be added .... per cent to cover general expense and superintendence, profits, contingencies, use of tools, Contractor's risk and liability. If the Contractor shall perform any work or furnish any material which is not provided for in this agreement, or which was not authorized in writing by the Engineer previous to the doing of the work or the furnishing of material, said Contractor shall receive no compensation for such work or material so furnished, and does hereby release and discharge the Company from any payment therefor.

If the Contractor shall proceed with such extra work or the furnishing of such extra materials after receiving the written authority therefor, as hereinbefore provided, then such work or material, stated in the written authority of the Engineer, shall be covered, governed and controlled by all the terms and provisions of this afreement, subject to such prices as may be agreed upon or determined by the Chief Engineer.

If the Contractor shall decline or fail to perform such work or furnish such extra material as authorized by the Engineer in writing, as aforesaid, the Company may then arrange for the performance of the work in any manner it may see fit, the same as if this agreement had not been executed, and the Contractor shall not interfere with such performance of the work.

GRADING AND INSPECTION OF MAINTENANCE OF WAY LUMBER.

In the classification of lumber the question of the absence or presence of defects is one of the greatest importance, and the various lumber associations of the country have adopted standard grades for the kinds of lumber which they manufacture, according to which they grade their product by sizes and by the quality, as determined by the absence or presence of certain standard defects.

To insure uniformity, it is obviously desirable that in ordering and purchasing lumber the railroads follow standard specifications, which shall be considered as such by both the producer and consumer. This principle has been recognized in the association in the adoption of the standard specifications for Southern yellow pine bridge and trestle timbers, which are now the standard specifications of the Yellow Pine Manufacturers' Association and of the American Society for Testing Materials.

Since the adoption of these standard specifications, the Yellow Pine Manufacturers' Association and American Society for Testing Materials have issued these standard specifications in the form of a small pamphlet, and the manufacturers have attempted to live up to these specifications in the manufacture of grades of timbers applied to bridge and trestle construction. Apart from these specifications, comparatively little has been done in the way of formulating standard rules for the grading of maintenance of way lumber that are recognized both by the railways and manufacturers.

At the 1909 convention of the Master Car Builders' Association a committee was appointed to act in conjunction with similar committees from the American Railway Master Mechanics' Association, the Railway Storekeepers' Association and the lumber manufacturers' associations throughout the country, and to prepare specifications and grading rules for cars and locomotive lumber.

At the 1910 convention of the Master Car Builders' Association a report was submitted on this subject, which was subsequently adopted by the above referred to railway and lumber manufacturers' associations. This report consisted of a description of the various woods used by the railway companies for car and locomotive lumber, a list of standard defects, with appropriate photographs illustrating these, and the grading rules for each kind of lumber.

A great deal of the matter contained in these specifications is applicable to maintenance of way lumber, and several of the manu-

facturers' associations have submitted to this committee specifications for maintenance of way lumber, using the descriptions of woods and standard defects already adopted by these associations. These specifications are printed in full as an appendix to the report.

In submitting these specifications as a matter of information to members of this association, the committee wishes to emphasize that it is desirable to adopt a series of specifications of this character at the earliest possible date. The splendid results obtained from the joint adoption of such standard rules for bridge and trestle timbers has already been pointed out. The various lumber associations have indicated their readiness to co-operate with the members of this association for the purpose of having similar rules adopted for maintenance of way lumber.

The committee suggests that the work assigned to it for the next year consist in the preparation of similar specifications for classes and kinds of lumber not included in the specifications submitted in this year's report, and the consideration of those submitted with a view towards recommending the adoption of standard specifications for maintenance of way lumber.

The report is signed by: W. H. Sellew, M. C., chairman; F. H. Bainbridge, C. & N. W.; E. O. Faulkner, A. T. & S. F. Railway; R. Koehler, S. P.; Dr. Hermann Von Schrenk, St. L. & S. F.; B. A. Wood, M. & O.

CONSERVATION OF NATURAL RESOURCES.

In pursuance of the request from President Baker of the National Conservation Congress, a report was transmitted to Thomas R. Shipp, executive secretary of that organization, on September 3, 1910, by the chairman, of which the following is a part:

"On May 13, 1909, an elaborate report was transmitted to the committee by the National Conservation Commission, through its secretary, Mr. Shipp, containing valuable suggestions as to the possibilities of railway companies assisting the work of conservation by thorough methods of prevention and control of forest fires, the cultivation of timber for railroad purposes, the use of sawed instead of hewed ties, the use of treated timber, and the necessities for the extension of the supply of creosote, and other features relating to timber resources. This report was transmitted by the committee to the American Railway Engineering and Maintenance of Way Association, published by the association, and distributed throughout the country in one of its bulletins.

"Dealing directly, as it does, with those features of conservation that affect the railway companies and their patrons, and having a circulation among railway officers covering the United States, as well as large portions of Canada and Mexico, the results should be exceedingly beneficial to the cause of conservation.

"In March of this year the special committee was established as one of the standing committees of the association, at the same time the personnel was largely increased, bringing into membership a number of prominent railway officers of this country and Canada.

"The work of the committee has been divided into sub-committees for the purpose of specialization, with an outline for investigation as follows: (1) tree planting and general reforestation; (2) coal and fuel oil resources; (3) iron and steel resources.

A sub-division of the work, as per statement following, was recommended: (1) Tree Planting and General Reforestation, (a) extant of existing forests considered in connection with increase of growth and consumption (b) judicious selection of tree varieties for planting, the locality and soil conditions considered. Possibility of value from growth on cut-over land. (c) methods of planting and cultivation, with cost of same, considering possibilities from cut-over lands. (d) anticipated results at maturity from trees so produced. (e) methods and cost of caring for and protecting existing forests. (2) Coal and Fuel Oil Resources. (a) extent of existing supplies, considered in connection with consumption. (b) extent of waste in production. (c) economic consumption, giving consideration to practical use of by-products. (3) Iron and Steel Resources. (a) supplies of raw material, considered in connection with consumption. (b) waste in production. (c) best methods of protecting finished products from destructive influences

"The committee will continue on the lines of investigation as shown, and holds itself in readiness to co-operate with the National Conservation Commission and its kindred and subsidiary organizations, as well as other national societies for the furtherance of the great principles of conservation of the national resources."

The very serious forest fires that occurred in the fall of 1910 were the subject of thorough discussion at a meeting of the Lake States Forest Fire Conference, held in St. Paul under the auspices of the Minnesota State Forestry Board and Minnesota Forestry Association, December 6 and 7, at which meeting the following was included in the resolutions adopted:

"We further recommend that the burning of all debris on the rights of way of the various railways be under the control and direction of the State Forest Patrol. Further, That under special conditions directed by the State Forest Patrol, the railway companies maintain a patrol, properly equipped, following their trains: also that all railway and logging locomotives and traction engines must be equipped with the most practical spark-arresting devices (subject to inspection and approval of the commission)."

The report is signed by A. S. Baldwin (I. C. R.), chairman; E. O. Faulkner (A. T. & S. F.), vice-chairman; Moses Burpee (B. & A.), W. A. Bostwick (Carnegie Steel Company), F. F. Busteed (C. P. R.), E. B. Cushing (S. C. L.), W. F. H. Finke (S. R.), J. W. Kendrick (A. T. & S. F.), A. L. Kuehn (American Creosoting Company), G. A. Mountain (Canadian Railway Commission), William McNab (G. T.), C. L. Ransom (C. & N. W.).

A motion to receive the report as a progress report was carried.

ELECTION OF OFFICERS.

The following were elected officers of the association for the ensuing year:

President, W. C. Cushing; vice-president, Edwin F. Wendt; secretary, E. H. Fritch; treasurer, G. H. Bremner, directors, three years each, A. S. Baldwin, C. F. Loweth.

PRACTICE REGARDING THE MANUAL.

The President: The subject of practice regarding the Manual will be a fruitful topic for discussion. Before we proceed with that, I would like to read from the fourth annual proceedings the remarks made by Mr. Berg: "It is desirable for the board of direction to consider the question of appointing a standing committee on standard specifications and definitions, whose duty it shall be to prepare final standard specifications and definitions, based on the adopted reports of the various existing standing or special committees on investigation, presented heretofore, or to be presented hereafter to the association; the work of this committee to be in the nature of a board of review, or revision, so that it can present to the association uniform and complete specifications or lists of definitions, which, if adopted by the association, shall be known and published as the recommended standards of the association."

Mr. McDonald: Without any idea of casting doubt on what Mr. Berg did, I would say the Manual, as shown by the minutes of the board of direction, was first suggested by A. W. Sullivan, our vice-president. It was done in the earlier days of the association, but was not put into effect until some time later. There seems to be quite a strong sentiment among a large number of our members that we should not publish a Manual as representing the selected subjects and matters which this association has acted upon, and I think it is due to the board of directors that they should know it, so we can abandon the plan of adopting standard specifications, and create ourselves into a body for the purpose of eliciting information from its members, and publishing it broadcast. We must pursue one course or the other, and I think it should be our aim to endeavor to promulgate specifications which can be used in securing competitive prices by the purchasing agents. I believe that a board of review should be appointed, and it should not be from the board of directors, but from the membership at large.

Mr. Kittredge: I should be very sorry indeed to see the Manual done away with. I appreciate that it is very difficult for an association with such a large attendance to discuss thoroughly and put into final shape the reports of more than one or two committees. I think the remarks by Mr. Berg in regard to the Manual contain a good deal that is worth considering. The question of appointing a board of review, outside of the board of direction, is rather a new thought to me, but if such a board could be obtained—and I have no doubt it could—I believe it would be better than to have it made a part of the duty of the present board. The members of the board of direction, when they get together, have a great many things to discuss. The work of editing and collecting, comparing and adjusting the various recommendations so that there will be no two in conflict, will take an enormous amount of time and careful study. I think it is absolutely essential, now that our Manual has reached the size it has, that it should be very carefully and closely edited in all its parts, so that there may not be discrepancies between the different parts.

Mr. McDonald: In order to get an expression and discussion on the question, I move that we discontinue the publication of the Manual.

Motion seconded.

Mr. Brooke: It would be a great loss, not only to the association and all its members, but to the railway world in general, to discontinue the publication of our Manual, which goes all over America and to foreign countries as a reference book. It would be a great advantage to have the matter thoroughly reviewed and edited before being published, and all unnecessary and conflicting matter eliminated or brought into conformity.

Mr. Byers: It seems to me the question of the desirability of publishing the Manual is not entirely what some of us have in mind. The Manual is a source of information, is a very desirable and useful thing and it is very desirable that we shall continue to collect information of the character that we are placing in the Manual, and bring it together as it is brought together in the Manual. It seems to me the question is the degree of backing that this association shall give to what the Manual states is recommended practice. There are several reasons why it is not entirely desirable that we shall give too much backing to these recommendations. I think most of us have occasion, at times, to deal with the courts, and sometimes I think there has been an experience that the Manual can be used in the courts to increase the difficulties of the engineers in dealing with the problems that he must confront in that way. The Manual is apt to be taken as being not a recommended practice, but the only recommended practice. That is certainly not the case.

Mr. Rose: The necessity for the Manual is to bring disjointed reports together, where one can find easily the work of the association. If the Manual were discontinued, it would be necessary to search through all the volumes of the association's proceedings to find out what the association thought about different things. It has occurred to me that we might have two Manuals, one called "The Manual of Recommended Practice," and the other, "The Digest of the Committees' Recommendations," or "Committees' Reports."

The President: "Manual for Railway Engineering and Maintenance of Way Work."

Mr. Trimble: The aim was to get a title for that book, which would not indicate that the practice embodied in the book was the only practice that might be acceptable.

Mr. Loweth: The Manual is good or bad, depending upon what is put into it. It seems to me we might very well have just the discussions and the votes that we take here in the convention, and then before anything goes into the Manual, have it voted upon by letter ballot, so that nothing will go into the Manual unless it is approved by a majority vote of the membership of the association.

Mr. Camp: If the Manual was not to be used I would be in favor of some kind of an index which would refer the reader back to the volumes of the proceedings in which the subject might be found. The Manual should aim to cover principally the fundamentals of the subject, the underlying principles. If it is attempted to go into detail as largely as has been the case heretofore, the Manual will not be successful, because we will have to keep revising it every year or two. In regard to the responsibility of the association in recommending certain things, I think it would be a splendid thing to have on the title page of the proceedings of the association and of the Manual a statement to this effect: "It is the desire of this association that it be distinctly understood that practice which does not conform to the recommendation herein is not necessarily bad or incorrect practice."

Mr. Trimble: May I ask for the reading of the notice which it is intended shall be published in the Manual of recommended practice and in our publications? It might clear up some of this discussion.

The President: The extract from the constitution is as follows: "The object of this association is the advancement of knowledge pertaining to the scientific and economical location, construction, operation and maintenance of railways. Its action is recommendatory and not binding upon its members."

F. S. Stevens: It appears to be generally conceded that the Manual should be continued. It is also the general opinion, I think, that there should be a board of review or a committee on revision. I would offer, therefore, as a suggestion, that a board of review should include, ex-officio, the chairmen of all committees, so that in the matter of review they would have an opportunity to be heard. I think also we should have all ex-presidents on such a board, as these men have had the advantage of knowing everything that has passed before, and possibly we should also add some of the other officers. A board constituted in this way would be able to review the Manual in a very satisfactory manner, I think, and greatly improve the value of the publication.

Mr. Wendt: At the present time the next issue of the Manual is in print, subject to the modifications that this convention will make. Therefore, the money has already been spent. I am strongly in favor of a continuation of the publication of the Manual, because it enables us to readily turn to the results of the work of the convention, without looking through the large number of volumes which are already on the shelves of the libraries. Furthermore, the proceedings of this year are going to mean three volumes instead of two last year and one volume in former years; so that the number of volumes of our proceedings issued each year is increasing very rapidly.

The Manual ought to be an expression of the wisdom of this association. It is not such today. There are conclusions in the Manual that do not represent the wisdom of the engineers of this country and they have gotten into the Manual by virtue of a lack of consideration. The legal responsibility of the Manual need hardly be considered except from this standpoint: If a lawyer undertook to introduce the Manual into a court he would be immediately required by the rules of evidence approved by the courts to test the Manual by evidence, and unless he could prove by competent evidence that the principles outlined in our Manual were the common, ordinary and usual principles which govern railways in the district over which that court had jurisdiction, the Manual would have no standing. This is simply an application of the rules of evidence of the courts. We do get into trouble today because some portions of our Manual have not been thoroughly considered. For illustration: An attorney called me up some time ago and asked, "Will you come over to court and testify for our company in a damage case that the American Railway Engineering Association has decided that a certain clearance is required?" I said, "No, sir, I will not; firstly, because it has made no such decision; and secondly, if it has made any such decision, it would be unwise." The attorneys are being told by somebody that there is such a thing in existence as the Manual, that is above reproach, that is infallible, that contains the wisdom of the engineers of the country. That is not the fact, because adequate consideration has not been given to this question.

I think we should continue the Manual, but divest our minds of any thought of issuing it in a way to indicate that it represents that which is infallible, or that which does not admit of variable application. It does seem to me that we could well afford to have a Manual that would contain standard specifications under which ballast can be purchased; standard specifications under which rails can be purchased; standard specifications for track bolts, track nut-locks, spikes, screw spikes, tie plates, frogs, switches, guard rails, etc.; specifications which would enable railways to get competition in the matter of prices, and specifications that would enable the railways to reduce their stock piles.

In my judgment the specifications contained in our proceedings are just as binding from the standpoint of responsibility when published in the proceedings as when published in the Manual, and the specifications submitted by the committee on frogs and switches this year, and the specifications submitted last year are the best specifications ever put out in this country at the present time. I have compared them with the New York Central and Pennsylvania Lines specifications and I make that statement. So far as the Manual is concerned, we can well afford to delay the publication of certain standard specifications, using one illustration, until such time as we are confident that they are complete and that they represent the best practice under which railways could make purchases all over the country.

I hope, gentlemen, that there will be no decision to discontinue the Manual, because the voluminous proceedings of the association require that there shall be a digest. We should divest our minds of the idea that the Manual commits us in any further degree from the standpoint of legal responsibility than the proceedings.

M. C. Byers: I move as an amendment to the motion before the house, that the governing committee present to the association a letter ballot giving the members an opportunity to decide upon which one of the three following things they wish done:

First, the abolishment of the Manual; second, the continuation of the Manual as at present; third, the continuation of the Manual in a modified form as suggested by the governing committee at the time of sending out these bulletins.

Motion seconded.

Mr. McDonald: My object in presenting the original motion was to draw out discussion on the matter, and I think the discussion has been quite illuminating. With the permission of the gentleman who seconded me, I now desire to withdraw the motion.

Motion withdrawn.

Mr. McDonald: My own opinion is, instead of taking any action, it should be delegated to the board of direction for such action as they see fit.

The matter was referred to the board of direction for such action as it deems the interests of the association warrant.

CONCLUDING BUSINESS OF THE CONVENTION.

It was announced that the change in name of the association to "The American Railway Engineering Association," and amendments to the constitution, submitted to letter ballot, had both passed.

A resolution was passed expressing the thanks of the association to the committee on arrangements for its earnest efforts. The committee on arrangements presented the retiring president with the first pin bearing the new name of the association. The convention then passed a resolution expressing appreciation of the work of the retiring president, and the convention adjourned.

THE UNIVERSAL METALLIC TIE.

For years there has been a strong and growing demand for a railroad tie possessing all the essential qualities of the wood tie, a tie that is simple in construction, feasible in its operation and economical in cost; a tie that will reduce railroad wrecks to a minimum, last a lifetime, and yet do away with the use of wood. It is very evident that a successful tie made of a substance practically everlasting and inexhaustible and meeting the requirements in railroad construction, will receive the universal approval of railroad men. The demand is strong, the field unlimited, and the railroad builder will eagerly welcome such a tie.

The Universal tie consists of a trough construction steel body, the rails rest directly on small oak blocks on end, that is, with the grain vertical. The track is fastened to the tie by means of plates which are bolted on each side of the wooden block by means of a single long bolt; these plates extend through a channel cut in the bottom of the trough. The plate rests in a slot cut in the upright portions of the tie body. This device holds the track from spreading. The plate is bent and hooks over the base of the rail. The sides of the trough are cut out under the rail, so there is no metallic contact at this point, and the full cushioning effect of the wood is obtained. The tie is easily and well insulated from the fastening plates by a single bent fibre on each side of the rail. This fibre fits over the top and sides of the rail base, and does not lay under the rail base. The fibre, then, is not subjected to the weight of trains, but only to the sideways thrust and upward pull. Thus the insulating fibre is subjected to less wear and consequently will last longer.

The advantages claimed for this tie are:

(1) Does away with spikes, rail anchors, tie plates and braces.

(2) Longer life, and resultant final economy.

(3) Prevents track spreading and getting out of gage and alignment.

(4) Being fireproof, it will prevent accidents which sometimes happen on account of burnt out ties on bridges or trestles.

(5) Reduces maintenance cost materially.

(6) Can be easily and well insulated.

(7) Will give a better roadbed, because the roadbed will not have to be often disturbed for tie renewals.

The Universal tie is manufactured by the Universal Metallic Tie Company, of Salt Lake City, Utah.

Rock Island Announces Bonus System.

The Rock Island System announces that it intends to install a system of rewards for the men in charge of track maintenance. The announcement was that in the future the roadmaster who keeps the roadbed under his direction in the best condition will be given $100 each year, and that the section foreman who has the best stretch of track will be given $50.

The Western Maryland has ordered 4,000 tons of rails from the Maryland Steel Company.

The Illinois Central R. R. is reported to have ordered 20,000 kegs of track bolts and spikes.

The Boston Elevated Ry., Boston, Mass., has ordered 1,000 tons of rails from the Pennsylvania Steel Co.

The Knoxville, Sevierville & Eastern Ry. is reported to have ordered 1,900 tons of rails from the Tennessee Coal, Iron & Railroad Co.

The New York, Chicago & St. Louis is said to have ordered 4,500 pairs of Duquesne joints from the Carnegie Steel Co.

The Pere Marquette has ordered 700 tons of structural steel from the American Bridge Company, and 500 tons divided between the King Bridge Company, the Lackawanna Bridge Company and the Wisconsin Bridge Company.

The Harriman Lines have ordered 72,000 tons of rails divided up between the Colorado Fuel & Iron Co., the Illinois Steel Co. and the Tennessee Coal, Iron & Railroad Co.

The Signal Department

The Signal Exhibit.

At the Coliseum, Chicago, March 20-24, the exhibition of signaling devices was a monument to the men responsible for the present status of the art. It is safe to say that as compared with the exhibition of one year ago, as much improvement was noticeable in design and system as in the previous decade. Credit for such phenomina is due to the rapid introduction of alternating current signaling for steam roads; constant striving for efficiency, fostered by keen competition; and the keen interest recently displayed by the interurban roads in automatic block signaling. Indeed, signals for interurban roads and alternating current devices were conspicuous above all else in the exhibits of the signal companies. The makers of accessory devices have not been behind hand. Remarkable improvement was noticeable in batteries, crossing bells, battery wells, wire and other supplies as well.

MEETING OF THE RAILWAY SIGNAL ASSOCIATION.

The March meeting of the Railway Signal Association was called to order at 10 a. m. on Monday, March 20, at the Congress Hotel, Chicago, with large attendance, C. E. Denny, signal engineer of the Lake Shore, president, in the chair. The preliminary report of Committee No. 1 on signal symbols was the first business considered. J. C. Mock, chairman of the sub-committee on standards, handled the report. Mr. Mock stated, in connection with the reading of the report, that the standards, as presented, were substantially as submited by a committee of manufacturers and approved by Sub-Committee No. 1. (The symbols submitted are presented herewith. The report itself merely recites the labors of the committee and recommends the adoption of the symbols.)

In discussing the report W. H. Elliott, signal engineer, New York Central, said that Plate 1 was a complete scheme, but objected to several departures from current practice, notably the method of designating upper and lower quadrant. T. S. Stevens, signal engineer, Santa Fe, regarded the manufacturers as good authority on the subject and thought that the result of their deliberations should not be passed over lightly. W. G. Hovey explained that the committee of representatives of manufacturers, when they first took the matter up, had three different schemes, which had been discussed and boiled down into the one submitted. He said that the manufacturers, having to deal with all of the railroads, would like, at the earliest possible day, to see some scheme adopted that will become standard with all of the railroads. J. M. Waldron, signal engineer, Interborough Rapid Transit Co., said that some roads use left-hand signals, and he found nothing in the report to indicate such. Some thought that for left-hand signals it would be satisfactory to use the same symbols with the blade shown on the other side of the post. Mr. Dryden found fault with the report because it was not extensive enough, not providing a distinction for signals operated by direct or alternating current, or by high or low voltage, and he could name other shortcomings. Mr. Stevens said that he had seen an attempt at covering by symbols every conceivable design or type of signal practice, with the result that a chart about a rod long was required, and there was evident confusion rather than system. Frank Rhea, of the General Electric Co., said that the committee had changed existing practice as little as possible in its scheme. A scheme of nomenclature for covering unusual practice had been carefully considered by the committee, but they had found that this would require seven characteristics, instead of the two recommended by the committee, and in addition a dictionary would have to be compiled to keep record of the system. G. A. Mountain, chief engineer of the Board of Railway

PLATE 1. SYMBOLS FOR SIGNALS.

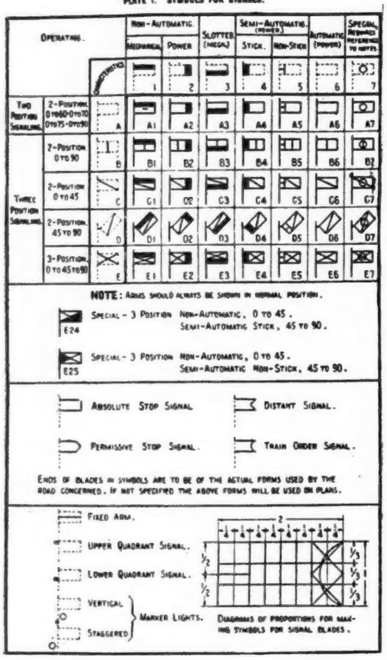


PLATE 2. SYMBOLS FOR SIGNALS—CONTINUED.

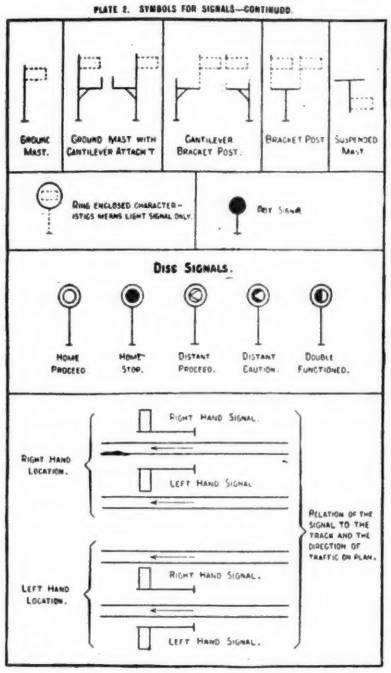
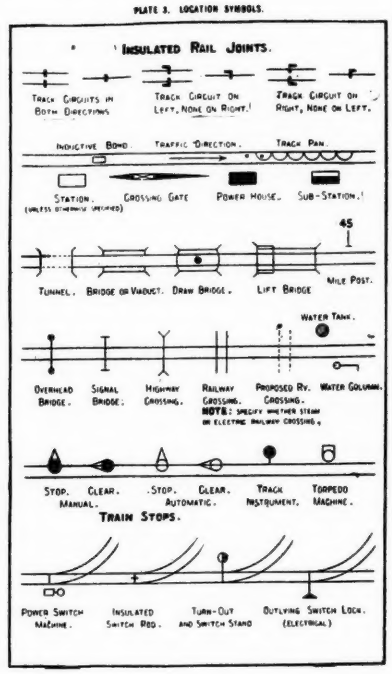


PLATE 3. LOCATION SYMBOLS.



Plates 1-2-3, Report of Meeting of Railway Signal Association.

PLATE 4. LOCATION SYMBOLS.—CONTINUED.

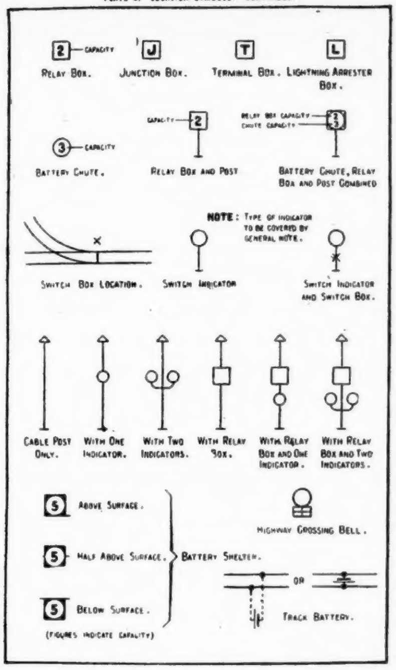


PLATE 5. LOCATION SYMBOLS.—CONTINUED.

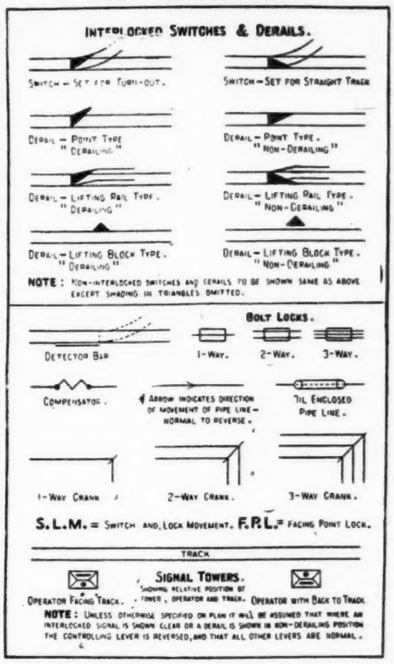
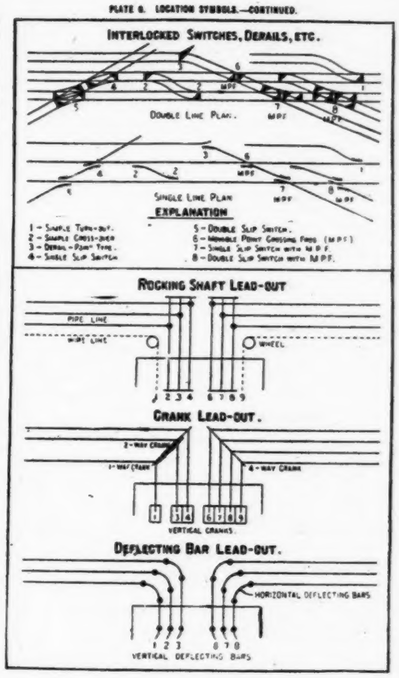


PLATE 6. LOCATION SYMBOLS.—CONTINUED.



Plates 4-5-6, Report of Meeting of Railway Signal Association.

Commissioners for Canada, being invited to take part in the discussion, inquired whether the committee had provided for cases where signals must be removed in the installation of new or improved plants. Mr. Rhea explained that in such instances signals to remain could be shown by full lines, signals to come out could be shown by dotted lines, and additional signals could be shown in red. Where a new installation is to replace an old one, the best way, perhaps, is to show one plan for the old plant and another one for the new plant.

In reference to Plate 3, H. S. Balliet suggested that the words "inductive" bond should, in order to have the practice of the association uniform, be changed to read "impedance" bond. Mr. Elliott suggested changes in the symbols for insulated rail joints and for power switch machine. Mr. Balliet suggested that a distinction should be made between power sub-stations and signal sub-stations. He would also have the track plan enlarged to show whether, on an electric road, the rails are bonded for power transmission, or whether there is a third rail for transmission purposes. In the fifth set of

PLATE 7. SYMBOLS FOR CIRCUIT PLANS.

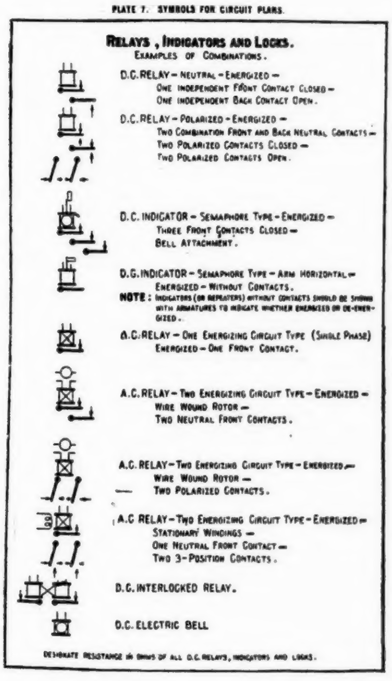


PLATE 8. SYMBOLS FOR CIRCUIT PLANS.—CONTINUED.

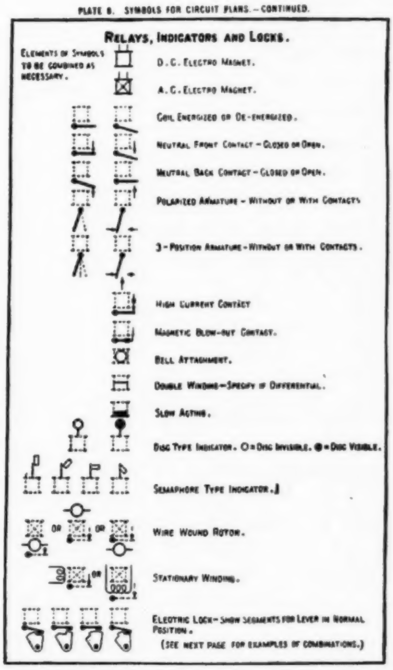
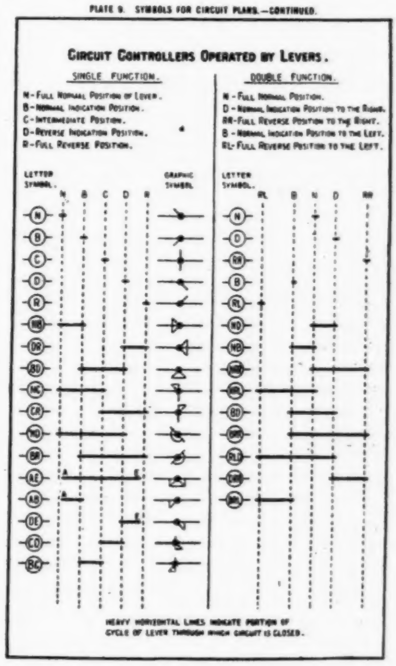
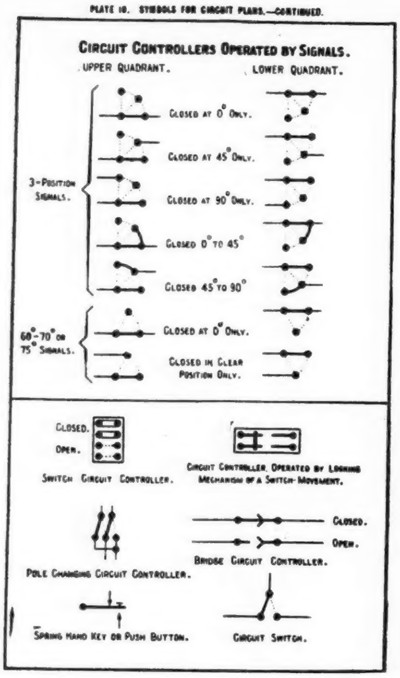
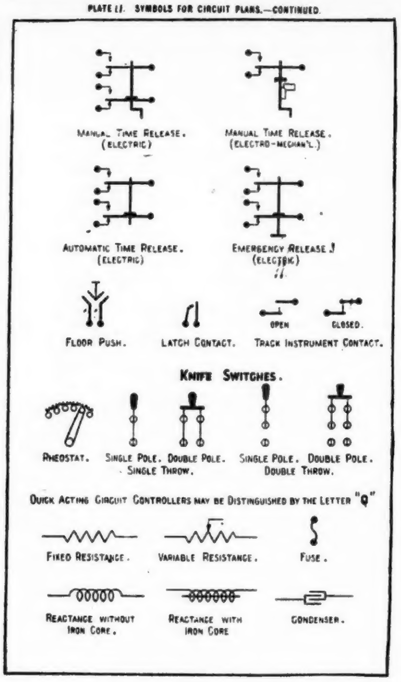


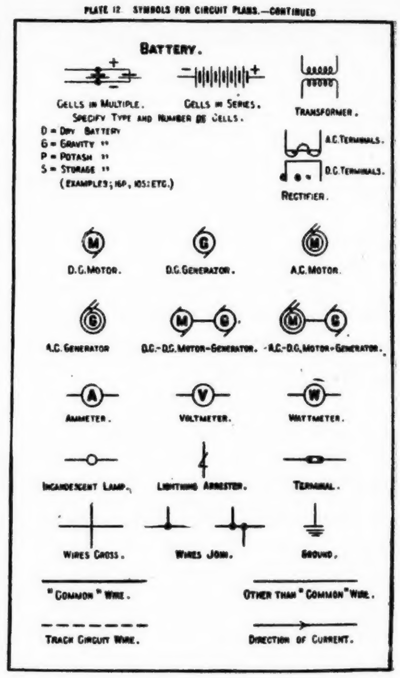
PLATE 9. SYMBOLS FOR CIRCUIT PLANS.—CONTINUED.



Plates 7-8-9, Report of Meeting of Railway Signal Association.







Plates 10-11-12, Report of Meeting of Railway Signal Association.

There were also mechanical interlocking devices, electric locks, etc.

symbols on Plate 8 he would advise the addition of a symbol to show a track gong.

In discussing Plate 4 Mr. Elliott thought that the cross indicating a switch box should be shown in a circle. W. H. Arkenburgh suggested the use of the letter "B" for track battery instead of the symbol submitted by the committee. Such is the practice of the Rock Island.

Mr. Balliet called attention to the use of the term "Signal Towers" on Plate 5, whereas the American Railway Association and other associations in authority have adopted the use of the designation "signaling station." A. G. Shaver, signal engineer, Rock Island, said that Mr. Balliet was undoubtedly correct, but not one man in a hundred having to do practically with railway signaling plants speaks of a tower as a "station."

Referring to Plate 7, Mr. Balliet suggested that the ohmic resistance of relays be indicated by figures, either within the limits of the symbol or outside thereof, with an arrow pointing to it. For knife switches, on Plate 16, Mr. Elliott recommended the use of a rectangle rather than the handle shown. For track circuit wire, on Plate 12, he would advise a full line instead of the broken one, and the symbol for "direction of curent" he thought should be eliminated, but others disagreed with him in reference to the latter point.

The rest of the morning and most of the afternoon was taken up by the chairmen of the various committees who made reports of progress only and very little discussion resulted. The last matters considered were the two papers, one on portable storage battery by Mr. McKeen, of the Oregon-Washington Railway & Navigation Co., and the other on alternating current signaling characteristics, by Mr. Howard, of the Union Switch & Signal Co. The discussion in each case was perfunctory. The papers will be published in our May issue.

SIGNAL EXHIBITS.

Union Switch & Signal Co.

This company showed an entirely new type of relay, at least one never before exhibited, viz., the radial type. In this relay, made either for direct or alternating current operation, the contacts are actuated by the partial revolution of a central shaft and terminate in binding posts on the circumference of the instrument, which has somewhat the appearance of a clock. It had also a multiple unit electric interlocking machine controlling signals and a switch movement of new design, all parts being included in an iron case. There was also an electro-pneumatic interlocking machine in operation controlling by alternating current, a switch and lock movement equipped with jaw type magnets and top post signals, one of which had a positive pneumatic movement to the stop position. Examples of each type of signal made by the company were on exhibition, together with two types of electro mechanical interlocking machines, an electric crossing gate and various auxiliary devices.

General Railway Signal Co.

This exhibit comprised an electric interlocking machine of their latest design, from which any lever may be removed without disturbing the rest. A new design of the now well known "2-A" signal was shown. This signal is for interlocking and stores its indication in the mechanism by means of a final movement of the gears independently of the arm, thereby doing away with the necessity for a special lever. It is also possible to slot this signal without a stick relay. Other modifications of the "2-A" design were also shown for a. c., low voltage and high voltage. There was also a complete line of relays, both alternating and direct current types. Perhaps the most interesting part of their exhibit was the so-called "absolute-permissive" automatic block system for single track roads in which the signals will show whether a train is approaching or receding.

Hall Signal Co.

The chief exhibit of this company was its relays, a great variety being shown, beginning with the old slate base, open type and ending with the very latest development. This company also had a new design of top post signal without a dash pot. In going to stop, the signal is retarded by a centrifugal friction device. It also had examples of the older and better known types of signals which they have made for a number of years. In addition there were many auxiliary devices, such as indicators, lightning arresters, etc.

Federal Signal Co.

This exhibit comprised an electric interlocking machine of the company's standard type and a new design of switch movement in operation. There was also a track diagram in which revolving cylinders indicate the presence or absence of a train in each track section after the manner of the well known illuminated diagram.

American Signal Co.

Here was shown a new type of top post signal in which the holding device consists of a magnet acting on a circular disk. The ends of the magnet cores are entirely covered with brass and support loosely as projections iron rings which, when magnetized, grip the circumference of the disk, but at other times are perfectly free to rotate. It had an electric interlocking machine of their well known type in operation, controlling an inclosed switch movement and several signals. There were also low voltage signals, both high and dwarf, and a complete line of relays.

General Electric Co.

In addition to a gas engine driven generator, mercury arc rectifier, switch board and other apparatus not directly bearing on signaling, this company had on exhibition direct and alternating current signals, relays, transformers, reactance coils, resistance units, indicators and other auxiliary apparatus.

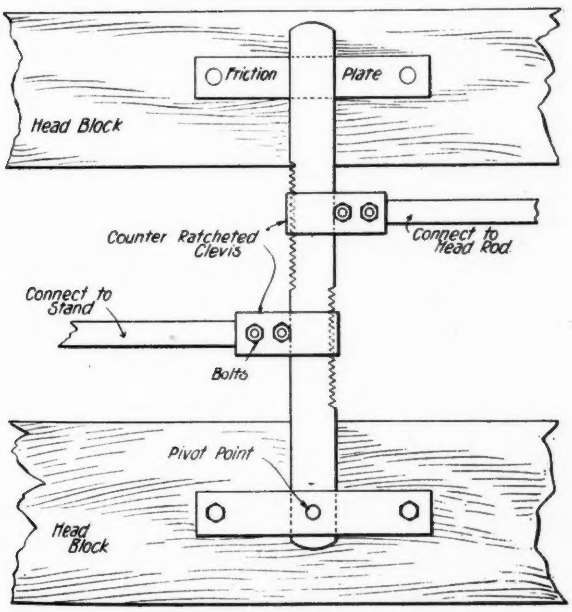
The Maintenance of Way Department

DIAL AND TRANSIT CLIPS.

Editor, Railway Engineering:

With reference to the use of dial or transit adjustment clips for head rods, I would prefer the dial clip. The transit clip, when used, gets head rod out of cross line of track. However, all adjustments which lengthen the head rod are in error. Keep up the full throw by using Ramapo stands, or an adjustable connection rod as per attached slip.

L. Dunn, Supervisor,
New York Central & Hudson River R. R.



Dunn's Patented Switch Point Adjustment.

[NOTE: We present herewith a cut of Mr. Dunn's patented adjustment for switch points. This device is designed to adjust the fit of both switch points by the use of an adjustment applied to the connection rod, so that a non-adjustable or rigid No. 1 switch rod may be used. The connection rod is cut in two and to each cut end a counter ratcheted clevis is attached. The fit of the points is then to be adjusted by moving laterally either counter ratcheted clevis, or both of them, if required, on the cross bar, one end of which is pivoted to one of the head block ties. The clevises may be moved independently. The farther the clevis connected to the stand is located away from the pivot, the lesser the angle of motion that will be imported to the pivoted bar, when the switch stand lever is thrown. The farther away from the pivot the other clevis is located, the greater the motion imparted to the switch points; and by locating both clevises correctly, the switch points may be made to fit tight against the rail on either side.—EDITOR.]

RAIL BRACES AND TIE PLATES.

Editor, Railway Engineering:

Your letter of the 17th at hand and would say that in my opinion it is not necessary to use rail braces throughout crossovers. We use the Goldie tie plates, which are far better than braces, and tie plate our entire crossovers. We do not use slide plates all the way across swiches. We use the short slide plate, except what we call the No. 1 gauge plate right at the point of switch which goes clean across, keeping track at switch point to proper gauge; this arrangement gives the very best of satisfaction. The Goldie plate gives a No. 1 result in keeping our crossovers in good condition at all times, even though the ties are badly decayed.

Roadmaster.

Editor, Railway Engineering:

I favor either rail braces or tie plates throughout crossovers. Of these I prefer the tie plate. Using tie plates adds to the life of the tie, and does away with rail braces; in the end tie plates are the cheaper.

Referring to slide plates under the switch points: We use slide plates across the entire tie, on the first eight ties under the switch points and stock rails. We aim to tie plate all our soft wood ties, where we can, even opposite the frog, where possible.

Roadmaster.

Editor, Railway Engineering:

Since tie plates came so generally into use I have entirely dispensed with braces on switch leads, using the shoulder tie plate instead, except on the slide plate at switches.

We use short slide plates at switches with braces on the outside except on the head block or first tie at the point of switch, where we use a long plate reaching across under

both rails: we use a cast steel brace at each end of this plate with either a block riveted onto the plate or the ends of the plate turned up to hold the outer end of the brace; this holds the gauge of the track at the point of switch absolutely secure. Where we have track circuits this plate is cut in two in center and insulated.

Supervisor.

Editor, Railway Engineering:

It is our practice on this line to use tie plates throughout on all crossover switches and main line turnouts; we do not use rail braces except where we have very heavy traffic, where we use derail braces in addition to the tie plates. The rail braces hold the rail from turning over and tie plates hold the rails from spreading. However, where traffic is normal I find that tie plates give perfect satisfaction.

Relative to use of slide plates for switches, we use the 15 and 18-ft. switch points on most of the main track turnouts except at the end of double tracks where we use 24-ft. switch points and a No. 14 turnout. We use the slide plates under both rails, and every second plate has a brace riveted on same; 8 slide plates are used under an 18-ft. switch; these 8 plates extend about three-fourths of the way from point back. We also use a gauge plate at each point of switch, i. e., a plate made solid to fit on top of the No. 1 head block tie to hold track to standard gauge. The same condition applies to all switches used on this line.

Supervisor.

Editor, Railway Engineering:

I would prefer rail braces throughout crossovers and all switch leads, but think braces on every other tie are sufficient. I find that by putting rail braces on ties when they are put in, the full life of the timber can be utilized. Regauging cuts up a tie and shortens its life by one-third.

I consider short slide plates O. K., and if they are used with braces, on good timber, it makes the best secured track you have.

We have a lot of old stock: some switches made for 4-ft. 9-in. gauge, some for 4-ft. 8½-in. gauge; some old stands with 4-in. throw, some with 4½-in. throw, and some with 5-in. throw. Using a long slide plate would cause some confusion in handling this stock, but the short plates are easily adaptable to all. I think well of the tie plate for the heel of switches, for this plate supports both the heel of the switch and the stock rail.

I notice many men recommend that switch stands be placed on the closed point side of switch. Wish you would ask some of them to explain more fully, as you can put the bottom crank in same position to closed point from enginemen's side simply by changing position of throw lever.

[Note: Engineers and trackmen have advocated placing the switch stand on closed point side of switch, so that in case the No. 1 switch rod breaks the closed point will be unaffected and the switch still safe for main line traffic. Remarks from others on this point will be welcomed.—Editor.]

Editor, Railway Engineering:

In regard to rail braces, I would say that where rail braces are used, I would consider it good practice to use them clear through on crossovers.

As to the use of tie plates, I think the use of short tie plates under rails separately is sufficient after leaving the heel of the switch points, where the spread of the turnout rail from the main rail is sufficient to admit the single plate. The single plate would also be a great deal cheaper than the through plate. My experience with tie plates applied in this manner has been very satisfactory.

Roadmaster.

THE LOW JOINT WAS RAISED.

The president and party were on a tour of inspection, and were sidetracked for a belated train. They were trying to get some exercise by walking the rails, when the president discovered something. He called to the chief engineer and told him there was a joint that looked a little low. The C. E. called the general roadmaster, saying, "that joint is quite low and you had better see to it." The G. R. M. called to the assistant general roadmaster and said, "that joint is very low, have it attended to at once, and report to me when it is done." The A. G. R. M. called to the roadmaster, saying: "Tim, there is a d—— bad low joint down there—can't you see it? Git that raised d—— quick and don't be long about it ayther." The R. M. saw the section gang near and he shouted to Pat: "Pat, git that jint up quicker than h—l, before the next train comes." Pat called to Jimmy, who was working his second week on the section: "Jimmy, d—— your sowl, git your claw bar and hist up that low jint. Why in —— did you let it git down like that?"

The low joint was raised.—Graphite.

RAILWAY CONSTRUCTION.

Plans are being made to build the Georgia, Midland & Gulf from Athens, Ga., south via Milledgeville to Dublin, about 120 miles, thence south to the gulf of Mexico. J. R. Crandall, Midville, and J. O. Hall, Toomsboro, are interested.

Application for a charter has been made by the Elberton & Eastern Railway Co., Elberton, Ga. The company proposes to build a line about 50 miles long from Elberton southeast to Lincolnton, Ga., via Washington, Ga., and traversing Elbert, Wilkes and Lincoln counties. The petitioners are W. O. Jones, W. F. Anderson, J. H. Blackwell, L. M. Heard, R. L. Cauthen and Z. B. Rogers of Elberton; W. J. Adams, J. J. Wilkinson and J. A. Moss of Tignall, and M. A. Pharr of Washington, Ga. Capital, $500,000.

The plans of the Mexican Union call for a line from Torres, Sonora, Mexico, via La Colorado, Represo, Tecolote, Pueblo, Diezo and San Raphael to Ures, a total of about 65 miles. Contracts for the work have been let to Henrique Cubillas, Hermosillo, and track has been laid for over six miles. The work will be easy, the approximate cut and fill per mile will be 5,000 cu. yds. The line is to have maximum grades of 2.5 per cent and maximum curvature of 6 deg. The company now owns and operates the Torres, Prietas & Represo, and has 12 miles in operation from Torres, east to Minas Prietas.

The Fore River Shore Line has been organized in Maine to build from a point near Deering Junction, Me., to and along the South Portland water front of Portland harbor. W. F. Spear, president, South Portland; W. W. Thomas, treasurer, Portland.

The Sandy Valley & Elkhorn Ry., which is controlled by the Consolidated Coal Co., has awarded the contract, it is said, for the concrete and masonry work on its proposed 28 mile line to James Skene & Sons Co., Huntington, W. Va. This road has also ordered 5,350 tons of rails from the Carnegie Steel Co. F. E. Engler, Pikeville, Ky., is chief engineer.

The Maine railway commissioners have authorized the Maine Central to construct seven miles of new line from a point two miles east of Cumberland Junction, Me., to a point about eight miles northeast of Cumberland Junction. The new line is to have double-track, and is being built to avoid the Walnut Hill grade. It is expected to have the improvements finished by June.

The San Benito & Rio Grande Valley is to be built to Santa Maria, Texas, which is about 25 miles from San Benito. Track has been laid on 10 miles, and rails have been bought for 13 miles additional. The Hidalgo Construction Company, San Benito, has the general contract. The work is light, involving

the handling of about 8,000 cu. yds. a mile. The line is being built to develop the lands of the San Benito Land & Water Company and adjacent properties. Steam will be used as the motive power for handling freight, which will consist of sugar cane, cotton, winter vegetables and fruit, and gasoline motor cars will be used for passenger service. S. A. Robertson, trustee, and C. E. Ensminger, chief engineer, San Benito.

The Texas Central has amended its charter so that it can build an extension to complete the line from De Leon, Comanche county, Texas, northwest to Nolan. The line is now in operation from De Leon to Cross Plains, 40 miles.

The Southern Traction has been organized in Texas with office at Dallas, Texas, to build from Dallas, south to Waco, 100 miles, with a branch from Waxahachie, via Ennis to Corsicana, 30 miles. Contract for making the surveys and other engineering work has been let to the Fred A. Jones Engineering Company, Dallas. J. F. Strickland, president, Dallas, is also president of the Texas Traction Company.

The Southern Railway will soon make extensive improvements on the line between Atlanta, Ga., and Macon, involving the laying of about 20 miles of passing tracks and revision of grades. The passing tracks will be of the lap-sidings design, which greatly facilitates the movement of trains. These tracks will be placed at intervals of about five miles, and each will be long enough to accommodate four trains. During the last few months the Southern has completed the work of strengthening the bridges on this line and is now operating its heaviest locomotives over it.

The Shelby Northwestern has been incorporated in Missouri with $225,000 capital, to build from Shelbyville, Mo., to the northern part of Shelby county, 15 miles. The incorporators include: H. M. Houck, J. A. Hope, J. H. Byrd, G. L. Houck, G. Houck and J. A. Flapek.

Contracts aggregating $17,000,000 for new railroad construction were awarded on March 24 by the Grand Trunk Pacific Ry. They call for the construction of branch mileage of 619 miles, 265 miles of main line and 200 miles of additional branch line grading besides the construction of 140 station buildings and a number of hotel buildings. The branch lines provided for are as follows: Calgary branch, 143 miles: Battleford branch, 59; Melville Regina boundary branch, 100; Moose Jaw branch, 49; Prince Albert branch, 72; Biggar to Calgary, 50. The Grand Trunk Railways has also announced that it has bought 40,000 tons of steel rails from the Sydney. Cape Breton, mills to replace tracks in western Ontario.

The Memphis, Dallas & Gulf has projected extensions to complete a through line from Memphis, Tenn., southwest to Fort Worth, Texas, with a branch from McLeod, Ark., north to Hot Springs. Contracts for grading most of the 45 miles from Murfreesboro, northeast to Arkadelphia, will be let in sections of from one to five miles each. The company will carry out the track laying work with its own men. There will be eight steel bridges, each 60 ft. long; eight each 100 ft. long, and one 200 ft. long, on this section. There will be about 16,000 cu. yds. of embankment work and 7,000 cu. yds. of excavation a mile.

A contract has been given to the W. R. Felker Construction Company, to build the Kansas City & Memphis from Rogers, Ark., south to Fayetteville, about 30 miles. The line is to be extended east eventually to Memphis, Tenn. Col. W. R. Felker, formor president of the company, will be in charge of the construction. G. D. Locke, president; R. G. Hobbs, secretary, and W. B. Felker, treasurer, Rogers, Ark.

The plans for the Richmond, Magog & Stanstead call for building a line from Rock Island, Que., and Derby Line, Vt., on the United States border, north 50 miles, via Smiths Falls, Fitch Bay and Georgeville, thence along the shore of Lake Memphremagog to Magog then through heavy timber lands for about 20 miles to Kingsboro and via Melbourne, to Richmond. The line will be built through a rich mining district. The company expects to have about 25 miles finished this coming summer. R. H. Fletcher, general manager of the Fletcher Pulp & Lumber Company, Sherbrooke, may be addressed.

The Pere Marquette has given, a contract to W. E. Tench & Co., Detroit, Mich., for 40 miles of double-tracking work between Detroit and Toledo, Ohio. A large force of men and teams will be put to work at once, between Romulus, Mich., and Alexis, Ohio.

The National Railways of Mexico has started work on the line from Canitas, Zacatecas, Mex., west to Durango, in the state of Durango, Contracts for the grading and bridge work were let in the general contract to the Campania Constructora de Ferrocarriles for work on 100 miles, and contracts for the remaining section to complete the line will be let at an early date. Maximum grades eastbound will be 3 per cent., and westbound 1.2 per cent. There will be two steel bridges, each 250 ft. long, and two each 150 ft. long. The line, which is being built to carry ore, lumber and wheat, was first projected from Gutierrez, Zacatecas to Durango, and afterwards changed to connect with the old Central Line at Canitas.

The Piedmont & Northern Railway Co. has let the contract to William J. Oliver & Co., of Knoxville, Tenn., for building its proposed line from Greenwood via Anderson and Greenville to Spartanburg, S. C., about 95 miles. Estimated cost, $900,000 to $1,000,000. W. S. Lee, of Charlotte, N. C., is vice-president and chief engineer. The route from Greenwood is via Hodges, Donalds, Honea Path, Belton, Williamston, Pelzer, Piedmont and Gantt to Greenville. The rout between Greenville and Spartansburg is not definitely decided. The contract covers grading, masonry and trestles.

The Oregon-Washington R. R. & Navigation Co. has awarded to George Chew, 41 Mohawk building, Spokane, Wash., contract for work on its line between Spokane and Ayer, involving 400,000 cu. yds. earth excavation, 400,000 cu. yds. rock excavation and 750 ft. of rock tunnel. This work is located at Ayer Siding, Wash., and portions of it are to be sublet. The work is to be completed in 18 months. The general contractors on the Spokane-Ayer line are as follows: George Chew, 8 miles; Aschbaugh-Bruce Co., North Yakima, Wash., 7½ miles; Tribble Bros., Cheney, Wash., 3½ miles; G. A. Carlson & Co., Fernwell building, Spokane, Wash., 22½ miles.

The Sandy Valley & Elkhorn Ry., a newly incorporated company controlled by the Consolidation Coal Co., has awarded contract to Langhorne & Langhorne, of Richmond, Va., for building from the mouth of Shelby creek to the head of Elkhorn creek, in Kentucky 28 miles, through rough to rolling country. There will be 38 single-span girder bridges, ranging from 100 ft. to 14 ft. in length; also two tunnels through sand rock, one 700 ft. long and the other 230 ft., each being 18x21 ft. Connection will be made with the Chesapeake & Ohio at the mouth of Shelby creek. J. W. M. Stewart is president and treasurer; Frank Haas is consulting engineer, Fairmont, W. Va., and F. E. Englar, chief engineer, Pikeville, Ky.

The Lehigh Valley has, according to press reports, recently decided to make the single-track line, now under construction from Lumber Yard, Pa., to a connection with the main line at Hayes creek, 12 miles, a double-track line. The original cost, which was $1,500,000, including classification yard, engine house, shop for car repairs and fuel and water facilities, it is understood, will be increased to $2,200,000. Hyde, McFarland & Burke are the contractors. Grading work on the line is more than half finished.

Considerable progress has been made on the construction of the mountain section of the Grand Trunk Pacific, both westward from Wolf creek and eastward from Prince Rupert, B. C. There remains only about 400 miles of line not yet under contract, for which bids will be asked during the next two months. When these contracts are let, the entire line from Prince Rupert, east via Edmonton and Winnipeg Fort William, at the head of Lake Superior, 2,188 miles, will be either under construction or completed.

The Paris & Mount Pleasant, which operates 23.6 miles of line from Paris, Texas, to Bogota, is planning to extend the line southeast to Mount Pleasant, 32 miles.

The Milwaukee, Peoria & St. Louis has been incorporated in Illinois with $5,000 capital, to build from Peoria, Ill., north through the counties of Tazewell, Woodford, Marshall, Putnam, Bureau, Lee and Ogle to Rockford, in Winnebago county, about 120 miles. The headquarters of the company will be at Chicago. The incorporators include: E. C. Morton, F. C. Vehmeyer, J. H. O'Neil, F. B. Reed and F. Gardner, Chicago.

STRUCTURES.

The McKinley syndicate which controls a number of interurban electric lines is promoting a new bridge over the Missouri river in which several steam railways have become interested on account of the excessive toll charged on the present bridge. Plans for the new structure have been completed, and its cost is estimated at $400,000.

The Gulf, Colorado & Santa Fe is about to advertise for bids on the construction of a brick passenger and frame station at San Saba, Tex. The brick depot will be 124 feet by 27 feet 4 inches and frame freight house will measure 96 feet 6 inches by 24 feet. The cost of the two structures will be about $17,000.

The Canadian Northern is about to request bids for constructing a $250,000 bridge on its line west of Edmonton, Alta.

The Great Northern, it is said, will build a station at Mount Vernon.

The Northern Central will expend $30,000 for terminal improvements at Frederick, Md.

The Oregon-Washington Railroad & Navigation Company is having plans made for a station, it is said, to be built at Centralia, at a cost of $25,000. The same company has been ordered by the Washington state railway commission to build a station in Pomeroy, on which work must be started within 90 days, and complted within nine months.

The Baltimore & Ohio and the Chesapeake & Ohio roads have awarded the contracts for the steel viaducts to be built in Louisville, Ky. Grainger & Co., Louisville, have secured the contract for the steel superstructure, and the supports, which will be built of reinforced concrete, will be erected by B. C. Milner & Son. The cost of the work is about $600,000.

The Pennsylvania and the Wheeling & Lake Erie have agreed with the county commissioners to pay $90,000 of the total cost of $110,000, which it is estimated will be required for building a viaduct to carry Dunham road over the railway companies' tracks. The structure will be 48 ft. wide and will have a span of about 800 ft.

The Baltimore & Ohio repair shops at Sandusky, Ohio, are to be removed to Toledo, owing to the consolidation with the Cincinnati, Hamilton & Dayton.

The new terminal station at Winnipeg, which is being constructed by the Canadian Northern Railway, at a cost of approximately $5,000,000 for the joint occupation of the Canadian Northern and Grand Trunk Pacific railways will be opened next July. This building is being erected on the site of old Fort Garry, which was the nucleus of Winnipeg. The main building is 350 by 140 feet in area and is surmounted by a dome 190 feet in diameter and 100 feet above the street level. In connection with the station there are eight elevated tracks, each 1,650 feet long and capable of accommodating two trains of eleven coaches each.

The Norfolk & Western, it is reported, is contemplating the building of repair shops at Sandusky, Ohio.

The contract for the superstructure of the Quebec bridge across the St. Lawrence river was awarded by the Canadian government on April 5, to the St. Lawrence Bridge Co. The estimated cost is $8,650,000.

The Southern Ry. will erect a fireproof passenger station at Lynchburg, Va., to cost $50,000.

The Oregon-Washington Railroad & Navigation Company, it is said, is planning to put up a new freight house at Portland.

The Oklahoma & Golden City R. R. will construct six large bridges and several smaller ones on its line between Fairview, Okla., and Jefferson City, Mo. Jno. A. Giesel, Golden City, Mo., is general manager.

The Canadian Pacific, it is understood, will replace 13 wooden bridges with steel and concrete structures, and will put up 30 new bridges between Vancouver and North Bend.

The Atlantic Coast Line will build a viaduct over Magnolia crossing, just north of Charleston, S. C., at an expense of about $350,000. The surveys are now being made by the road's engineers.

The Memphis, Dallas & Gulf R. R. will construct eight 60-foot, eight 100-foot and one 200-foot steel bridges. A. M. Van Auken, Nashville, Ark., is chief engineer.

The Northern Pacific is planning to build a station and increase its yard and trackage facilities at Toppenish. It is understood that the improvements will cost about $80,000.

A chain of new stations will be built by the Monon company this year for which plans have already been drawn by Chicago architects. A station will be erected at Hammond to cost $20,000, one at Bloomington to cost $18,000, and one at Renssalaer to cost $15,000. A number of other smaller stations are to be built. The project by which certain railroads were to construct a big union depot at Hammond fell through, the Erie Railroad refusing to co-operate.

The Pennsylvania R. R. is contemplating bridge improvements at Altoona, Pa., to cost about $45,000.

The Licking River Ry., J. T. Johnson, general manager, will construct a 40-ft. steel bridge near Yale, Ky.

The Norfolk Teminal Ry. Co. is about to take steps for raising funds for the erection of the $2,000,000 union depot in Norfolk, Va. This depot is to be occupied jointly by the Norfolk & Western, the Virginian and the Norfolk & Southern roads.

The Coney Island & Brooklyn R. R., it is reported, will erect a new terminal at Coney Island at a cost of $100,000. Dodge & Morrison, 82 Wall street, New York, N. Y., are the architects.

The Chicago & Alton, the Cleveland, Cincinnati, Chicago & St. Louis, the Chicago & Eastern Illinois, and the St. Louis & San Francisco roads, it is reported, will erect a two-story brick and stone station at Granite City, Ill., costing $15,000.

The New York, New Haven & Hartford is said to have completed estimates for a new railroad bridge to span the Thames river at New London, Conn. The estimates reach $2,500,000 for a two-track bridge with piers adaptable to four tracks.

The Pennsylvania Lines West announce that $2,975,000 will be spent in abolishing grade crossings in Cleveland, O. Work is expected to be started about May 1.

The Southern Pacific has plans for the construction of a 20-stall roundhouse at Klamath Falls, Ore., and one near Portland with 12 stalls. In each case a full equipment of tools and machinery for general repair work will be installed.

The Kansas City Southern, pending certain concessions, will erect a union passenger station at Fort Smith, Ark., to cost $150,000.

The Cumberland Valley has prepared plans involving the expenditure of $500,000 to $750,000 in building its proposed line through Hagerstown, Md. A new passenger station, roundhouses, yards and terminal facilities will be provided.

The Southern Railway repair shops at Louisville, Ky., have been turned over to the Kentucky & Indiana Terminal Railroad Co., which it partially controls. It is reported that the shops will be considerably improved and enlarged.

The Western Maryland has decided to locate its main shops at Cumberland, Md., but the site has not yet been selected.

The St. Louis & San Francisco will construct freight yards and repair shop facilities at Memphis, Tenn., to cost about $250,000. A freight depot will be erected at some later date.

The Chesapeake & Ohio airbrake shop at Clifton Forge, Va., was recently destroyed by fire. The loss is about $4,000.

The Atchison, Topeka & Santa Fe will expend about $46,000 in the improvement of its repair shop facilities in Richmond, Cal.

The Yazoo & Mississippi Valley is understood to be considering the erection of a $100,000 roundhouse at Clarksdale, Miss.

The Southern Pacific has decided to spend $500,000 for improvements to its shops and to the shops of the Pacific Electric at Los Angeles. This includes an additional building, to cost $100,000, on which work is to be started at once. The Southern Pacific expects to make the addition at Los Angeles very important to the road and will set aside an ample sum to protect its cost.

The Illinois Central has announced that it will erect a passenger station at Memphis, Tenn., to cost about $6,000,000. The rearrangement of tracks in connection with this improvement will cost an additional $150,000.

The Atchison, Topeka & Santa Fe, it is reported, will expend about $1,000,000 in improvements, at Port Bolivar, Tex.

The Winnipeg, Salina & Gulf will construct five steel bridges in addition to a number of trestles along the route of its proposed line. Mr. C. A. Stayton is chief engineer, at Salina, Kan.

The Oregon-Washington Railroad & Navigation Co. is contemplating the expenditure of about $250,000 in the enlargement of its freight terminals and the construction of shops near Spokane, Wash. The work includes the construction of a 30-stall roundhouse, the erection of shops for the Oregon Railroad & Navigation Co. and the North Coast roads, and installation of extensive trackage facilities.

The Trinity & Brazos Valley will erect a three-story brick building at Kingsville, Tex., at a cost of $100,000.

The Chicago, Milwaukee & St. Paul has awarded a contract for 254 tons of bridge work to the Worden-Allen Co. and one for 390 tons to the Milwaukee Bridge Co.

The Wabash Railroad has ordered from 500 to 600 tons of bridge work from the American Bridge Co.

The Union Pacific is reported to have let the contract for rebuilding its Kaw river bridge at Kansas City, Mo., to the Foundation Co., of New York City, N. Y.

The Southern Ry. will erect a new freight station at Dalton, Ga.

The Pennsylvania R. R. will erect a new station at Port Deposit, Md.

The Piedmont Traction Co. is contemplating terminal facilities at Charlotte, N. C., to cost about $500,000.

The Pere Marquette is planning to construct two 400-ft. warehouses of brick and cement to cost about $75,000, at Saginaw, Mich. An addition to the machine shops and roundhouse at the same place will be made at a cost of about $50,000.

The Chicago, Burlington & Quincy will erect a $60,000 passenger station at Nebraska City, Neb.

IRON AND STEEL.

The Toledo Light Rail Co. has an inquiry out for 500 tons of light section rails.

The Harriman Lines have ordered 1,200 tons of rails from the Pennsylvania Steel Company.

The George's Creek & Cumberland has ordered 6,500 tons of rails from the Bethlehem Steel Company.

The American Locomotive Co. has ordered from 10,000 to 12,000 tons of 2x2 plain and other grades of iron, for April-September delivery, at its various plants.

Personals

G. P. Palmer assistant engineer of the Baltimore & Ohio at Chicago, has been appointed division engineer of the Baltimore & Ohio Chicago Terminal, with office at Chicago, succeeding E. N. Layfield, resigned.

D. K. Colburn, bridge engineer of the Galveston, Harrisburg & San Antonio and the Louisiana Western at Houston, Tex., has been appointed engineer of maintenance of way, with office at Houston. Mr. Colburn succeeds A. V. Kellogg, deceased.

C. B. Gorsuch, superintendent of the Wheeling division of the Baltimore & Ohio, at Wheeling, W. Va., has been appointed superintendent of the Pittsburgh division, with office at Pittsburgh, Pa., succeeding E. A. Peck, promoted.

T. H. Williams has been appointed assistant superintendent of the Stockton division of the Southern Pacific, with office at Stockton, Cal., succeeding G. D. Wright, assigned to other duties.

A. S. Bland, assistant division engineer of the Pennsylvania Lines West at Fort Wayne, Ind., has been appointed assistant engineer on the Chicago terminal division, with office at Chicago.

G. B. Herington, division engineer of the Sacramento division of the Southern Pacific, at Sacramento, Cal., has resigned to become superintendent of construction of the Mountain Quarries Co. Railroad. Mr. Herington's offices are at Auburn.

C. H. Niemeyer, division engineer of the Conemaugh division of the Pennsylvania Railroad, at Pittsburgh, Pa., has been transferred to the Pittsburgh division, and F. W. Smith, Jr., supervisor of the Philadelphia Terminal division, at West Philadelphia, succeeds Mr. Niemeyer, both with offices at Pittsburgh.

John Williams Corcoran, supervisor of roadway and track of the Pittsburgh & Lake Erie, has been retired under the pension rules of the company. Daniel F. Harvey has been appointed supervisor, in charge of roadway and track of sub-district No. 3, with office at Beaver Falls, Pa.

C. I. Leiper, division engineer of the New York Terminal division, Pennsylvania Railroad, at New York, has been transferred to the New York division, with office at Jersey City, N. J., and J. H. Harris, division engineer of the Delaware division, at Wilmington, Del., succeeds Mr. Leiper; W. F. Greene, division engineer of the Philadelphia Terminal division, at West Philadelphia, Pa., succeeds Mr. Harris, and W. T. Covert, division engineer of the Williamsport division, at Williamsport, succeeds Mr. Greene. G. R. Sinnickson, supervisor of division No. 2 of the Philadelphia division, at Paoli, has been appointed division engineer of the Williamsport and Susquehanna divisions, with office at Williamsport; J. Schimmel, Jr., supervisor of the Schuylkill division, at Reading, succeeds Mr. Sinnickson; D. C. Baird, assistant supervisor of the Pittsburgh division, at Pitcairn, succeeds Mr. Schimmel, and M. J. Jones, assistant supervisor of the Bellwood division, succeeds

Mr. Baird. S. E. Holland, supervisor of the Cresson division, at Barnesboro, has been transferred to the Philadelphia Terminal division, with office at West Philadelphia; R. R. Nace, assistant supervisor of the Maryland division at Lamokin, succeeds Mr. Holland; N. D. Vernon, assistant supervisor of the Monongahela division, at Dravosburg, succeeds Mr. Nace, and W. T. Bevan, transitman in the office of the engineer maintenance of way, succeeds Mr. Vernon. R. L. Fleming, transitman in the office of the engineer maintenance of way, has been appointed assistant supervisor of the Conemaugh division, with office at Blairsville.

Robert V. Massey, formerly division engineer of the New York division, Pennsylvania Railroad, has been appointed superintendent of the New York, Philadelphia & Norfolk R. R., with headquarters at Cape Charles, Va. Mr. Massey succeeds Elisha Lee, who has just been appointed assistant to the general manager of the Pennsylvania Railroad. Mr. Massey was born at Dover, Del., September 29, 1871. He graduated from Yale University in 1892, in which year he entered the service of the Pennsylvania Railroad. In 1895 he was attached to the office of the principal assistant engineer at Altoona, and on November 1 of the same year he was appointed assistant supervisor on the Western Pennsylvania division. April 1, 1897, he became assistant supervisor of the Baltimore division, and on April 1, 1899, assistant supervisor on the middle division. Mr. Massey was promoted to the position of supervisor on the Schuylkill division August 1, 1900. In 1902 he went to the Maryland division in the same capacity, and on December 15, 1905, to supervisor of division No. 13 of the Pittsburgh division. He became division engineer of the Schuylkill division on April 1, 1907, and on January 1, 1909, was apponted division engineer of the New York division, which position he held until his latest appointment.

Elisha Lee, who has been made assistant to the general manager of the Pennsylvania Railroad, was born in Chicago September 24, 1870. He graduated from the Massachusetts Institute of Technology in 1892, and in November of that year entered the service of the Pennsylvania Railroad in the office of the assistant engineer of the Tyrone division. He was made a rodman in 1897, and on April 17, 1899, was promoted to assistant supervisor on the Western Pennsylvania division. His subsequent appointments prior to being appointed division engineer were assistant supervisor West Jersey & Seashore Railroad, November 1, 1899; assistant supervisor Philadelphia division, July 16, 1900; supervisor eastern division, Philadelphia & Erie Railroad, April 15, 1901; supervisor Philadelphia division, November 10, 1902. On August 20, 1903, Mr. Lee was promoted to division engineer of the Buffalo and Rochester division. Three years later, he was appointed division engineer of the Philadelphia Terminal division, and on April 1, 1907, he became principal assistant engineer of the Philadelphia, Baltimore & Washington Railroad. On March 24, 1909, he was promoted to superintendent of the New York, Philadelphia & Norfolk Railroad, which position he held until his latest appointment.

W. H. De Witt has been appointed superintendent of the Fort Dodge, Des Moines & Southern, with office at Boone, Iowa, succeeding Frank Arnold.

J. M. Sims has been appointed superintendent and general freight agent of the Pacific Coast Railway, with office at San Luis Obispo, Cal., succeeding E. W. Clark, promoted.

A. C. Watson has been appointed assistant division engineer of the Pennsylvania Company, with office at Fort Wayne, Ind., succeeding A. S. Bland, transferred.

George Brophy has been appointed an assistant division superintendent of the Union Pacific, with office at Ogden, Utah.

T. A. Sweeney, trainmaster of the Chicago Great Western, at Des Moines, Iowa, has been appointed assistant superintendent, with office at Chicago.

J. C. Pratt, roadmaster of the Minneapolis & St. Louis at Watertown, S. D., has been appointed roadmaster of the Iowa Central, with office at Marshalltown, Iowa, succeeding M. H. Sheeley, resigned.

E. C. Morrison, division engineer of the Shasta division of the Southern Pacific Co., has been appointed division engineer of the Coast division, office at San Francisco.

W. H. Kirkbride, formerly of the Coast division, Southern Pacific Co., has been appointed division engineer of the Sacramento division, with headquarters at Sacramento, succeeding G. B. Herington, resigned to accept service elsewhere.

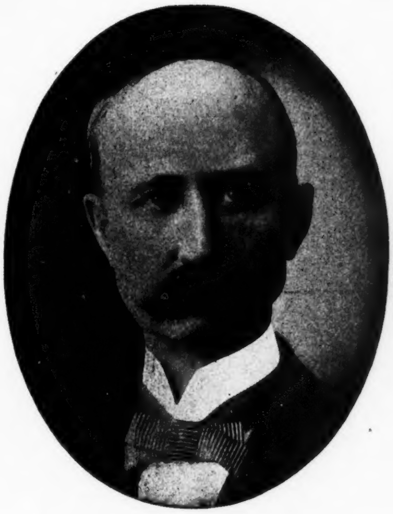
F. M. Siefer succeeds E. C. Morrison as division engineer of the Shasta division of the Southern Pacific Co., with office at Dunsmuir, Cal.

Among The Manufacturers

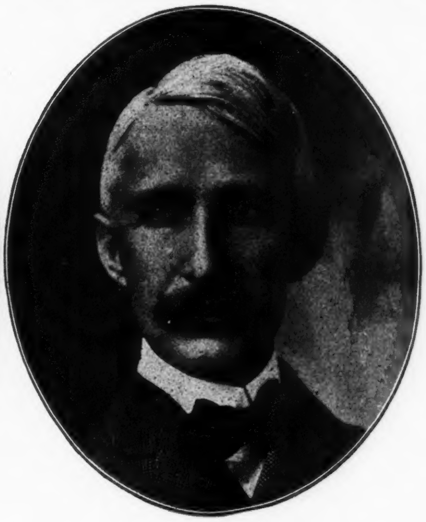
ROBERT E. BELKNAP, Penn. Steel Co., Pres. Railway Appliances Assn., 1911-12.

A. P. VAN SCHAICK, Lackawanna Steel Co., Vice-Pres. Railway Appliances Assn., 1911-12.

JOHN N. REYNOLDS, Railway Age Gazette, Sec. and Treas. Railway Appliances Assn., 1911-12.



W. H. FAIRBANKS,
Pres. Indianapolis Switch & Frog Co.



M. L. MILLIGAN.
Vice-Pres. Indianapolis Switch & Frog Co.

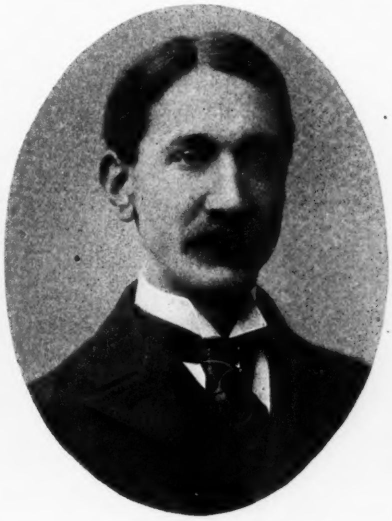
E. C. PRICE,
Sec. and Treas. Indianapolis Switch & Frog Co.

W. C. SHANAFELT,
Vice-Pres. and Genl. Mgr. Concrete Form & Engine Co.

W. D. WAUGH,
Asst. Genl. Mgr. Concrete Form & Engine Co.

L. K. RUMSEY,
Sec. and Treas. Concrete Form & Engine Co.

F. W. ALLEN,
Sales Agent Weir Frog Co., Cincinnati.



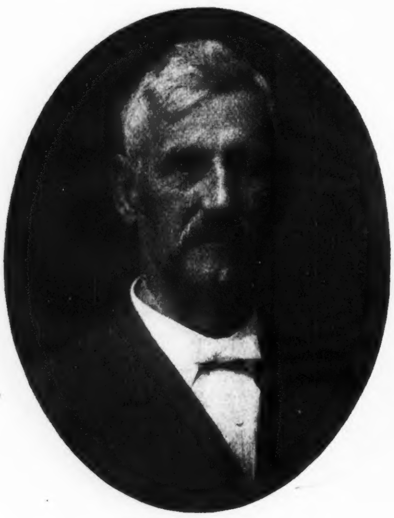
N. O. GOLDSMITH,
Ch. Engr., Weir Frog Co.

J. M. LORENZ,
Cent. Elec. Co., Chicago; Popularly Known as "Okonite Jim."

GEO. C. MARSH,
Pres. Marsh-Capron Co., Chicago.

SAMUEL F. NICHOLS,
Geo. P. Nichols & Bro.

W. M. KINCH,
Sig. Engr. Lutz-Lockwood Co.



JOHN M'KENZIE,
Pres. Johnson Wrecking Frog Co.

R. E. GRAY,
Mgr. Taylor Nut Lock Co.

E. W. TAYLOR,
Taylor Nut Lock Co.

MILTON BARTLEY,
American Nut & Bolt Fastener Co.

W. H. D. WHEAT,
Asst. Mgr. Harry Bros. Co.

J. S. CAVE,
Vice-Pres. and Genl. Mgr. Harry Bros. Co.,
New Orleans.

D. R. NIEDERLANDER,
Sec. and Treas., Adreon Mfg. Co.

E. L. ADREON, JR.,
Pres., Adreon Mfg. Co.

G. H. DOUGHERTY,
Sec., D. & A. Post Mold Co.

TEST OF WING FIRE-PROOF PAINT.

Recently T. G. Wing, business manager, and G. W. McCreary, secretary of the Gorman Fire-Proof Paint Co., St. Louis, gave a test of the qualities of Wing fire-proof paint before a large aggregation of business and professional men near Nelson Morris & Co.'s packing house. The test demonstrated that the paint is really fireproof.

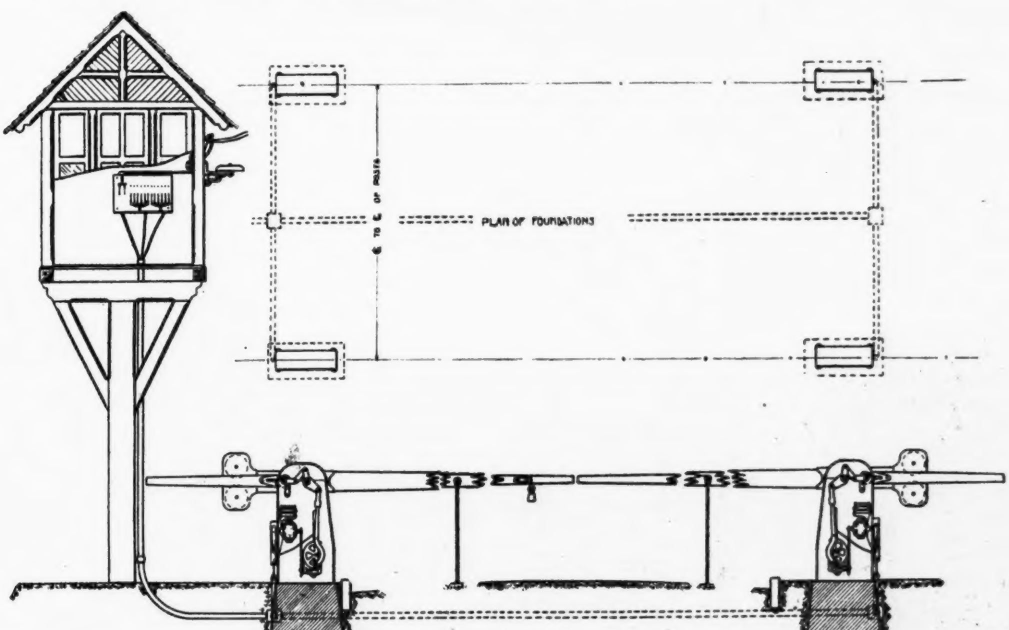
A number of planks from a pile of common pine lumber were taken and built in the shape of a shed, which was painted by a disinterested party, with the Wing fire-proof paint, giving it a coat of white on the under side and a coat of red on the outside. Then a lot of paper, shavings and kindling wood was placed under the structure. Five gallons of coal oil were then placed upon the wood and a match applied. After 20 minutes burning, when the kindling had burned out, the structure was removed and found to be perfectly sound. The boards were merely charred slightly. Some shingles were then painted on all sides with the paint and thrown into a like fire and allowed to remain ten minutes, then taken out, and when examined were found to be in good condition, charred only slightly.

BUDA ELECTRIC CROSSING GATES.

The Buda Co., of Chicago has placed on the market a very interesting crossing gate for use where an electric current is obtainable. The advantage of the electric gate which is shown in the accompanying drawing is the ease with which one man can operate gates for two or more crossings.

It is only necessary in the operation of the gates to close or open a switch. The current is automatically cut off when the gates swing into position. There is no lost motion and the time required to raise the gate is about eight seconds. The gates are made for either direct or alternating current.

This company also manufactures double and single cylinder pneumatic, pneumatic diaphragm, and mechanically operated gates.



Buda Electric Gate.

COMBINED TIE PLATE AND ANTI-CREEPER.

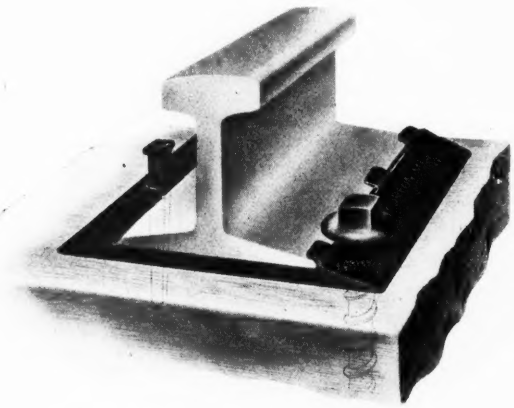
There is illustrated herewith a type of combined tie plate and anti-creeper. Adreon Manufacturing Company (makers of this device) claims many advantages for it. The locking device consists of a wedge, as shown in the illustration of the tie plate in position. This wedge is in addition to the track spikes which are ordinarily used.

The wedge, it is claimed, locks the rail to the tie plate and thus prevents track creeping. It also prevents any motion between the rail and the tie plate, and thus eliminates mechanical wear on plates and spikes.

Clarke tie plates are put under tension when the wedge is driven to place. The plate will remain in tension and fast to the rail. A plate of the same thickness (especially if it be flat bottomed) will wear out much more quickly from mechanical pounding if it is not locked to the rail. It is claimed that this combination plate (1) eliminates rattle when flat bottom plates are used; (2) locks to the rail so firmly that throat cut spikes, worn shoulders and broken plates are eliminated. It is obvious that its use does away with the expensive separate anti-creeper, and its cost for installation and maintenance.

The Adreon Manufacturing Company has offices in the McCormick Building, Chicago.

Clarke Tension Set Tie Plate.



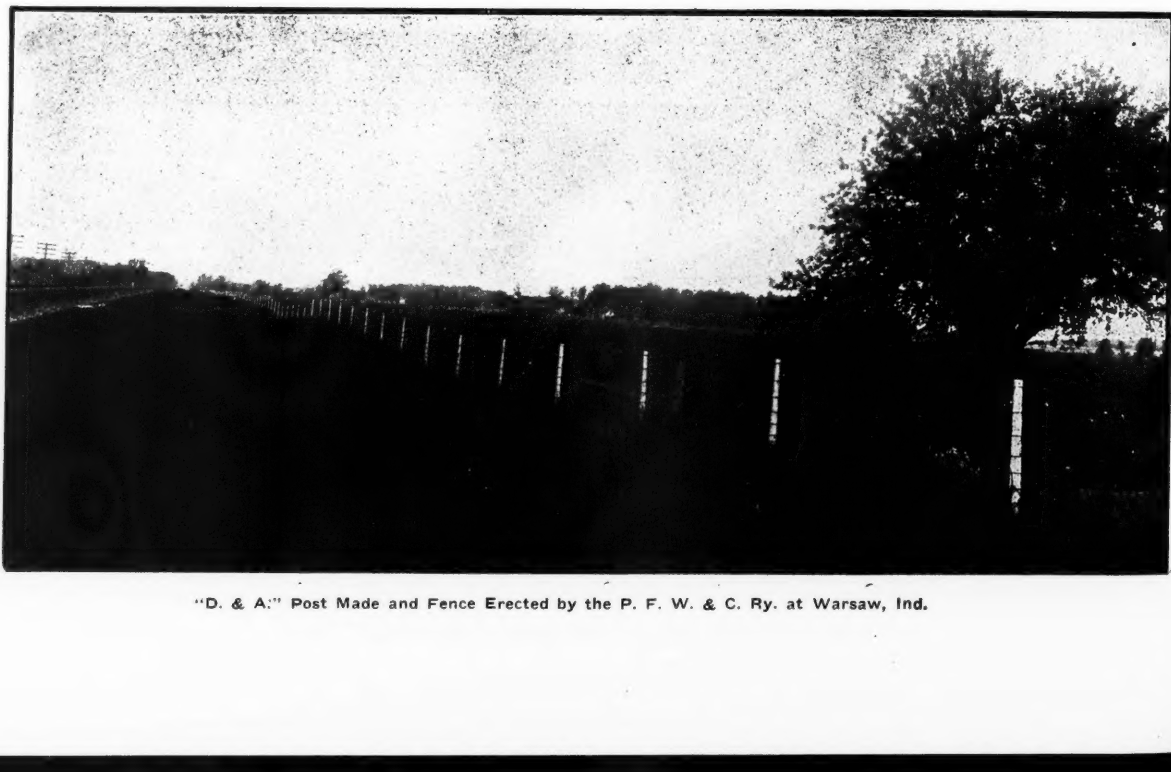
Clarke Tie Plate as Applied in Service.

CONCRETE FENCE PCSTS.

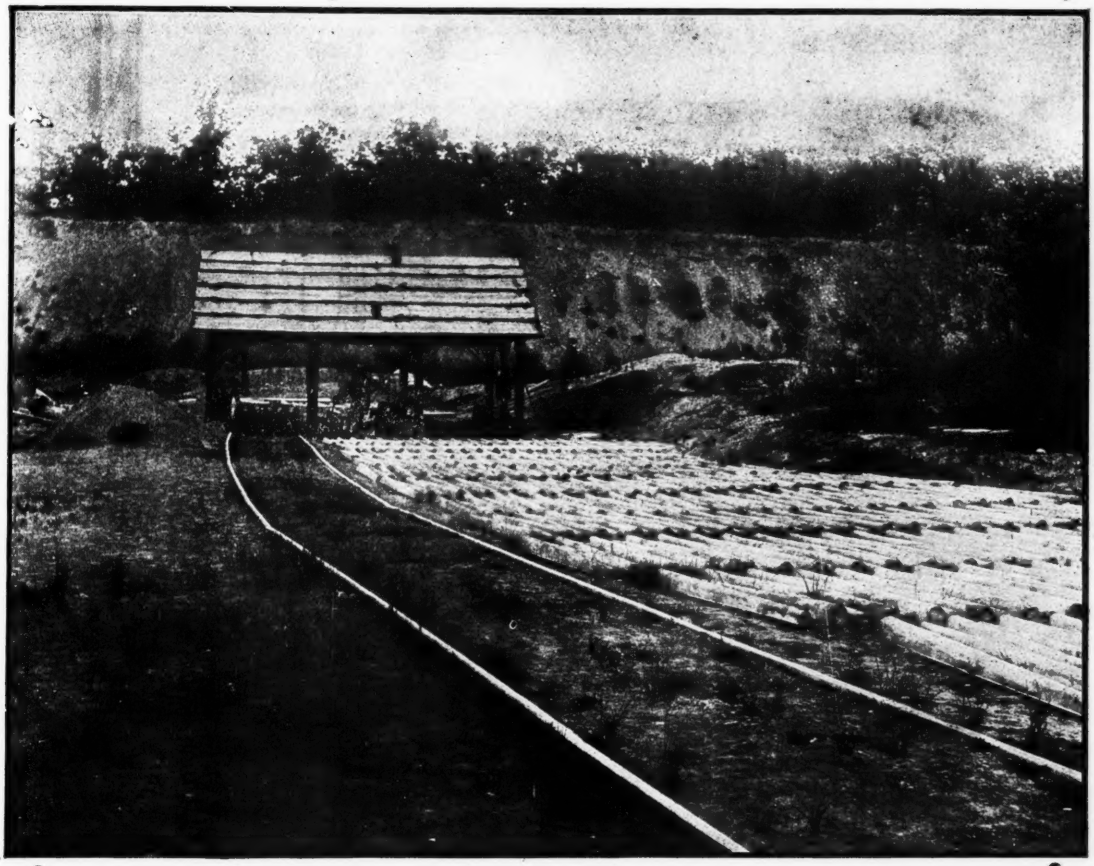
A number of railroads are using concrete fence posts to a considerable extent. The D. & A. Post Mold Co. is manufacturing a system of gang molds supported about two feet above ground on a frame called a "shaker"; hence called the "shaking system." The individual molds are "U" shaped in cross-section, making a post with a round back and flat face, so that there are no corners or crevices to fill in molding, no projections or holes through posts nor corrugations to weaken post.

The fence wire is designed to be placed on the flat side of the post and fastened by "tie wires," which wrap entirely around the post. A small tool called the "twister" is used which does the work rapidly and makes a very tight and strong fastening. This device utilizes the full strength of the post in the fastening, and it is possible to fasten in as many places desired, and at any points up and down the post. Staples, holes, corrugations, or any of the metal fasteners on the market may be used with the "D. & A." post. Such fastenings, however, tend to weaken the post; and metal is subject to corrosion. There is also the liability of breaking or bending. With such fasteners the expense per post is greater, because there is an expense for placing the device besides the expense for securing the fence to the fastener.

The mold being "U" shaped in cross-section, makes a post



"D. & A." Post Made and Fence Erected by the P. F. W. & C. Ry. at Warsaw, Ind.



P. F. W. & C. Ry. "D. & A." Cement Post Plant at Warsaw, Ind.

practically square without objectionable exposed corners, so that a whiffletree or hub of a wagon or object of like nature will readily slip by without damage, and there are no exposed corners to chip off in handling and expose reinforcement to corrosion. The "shaking" for settling the concrete used by this system is novel; it gives the post a very smooth dense troweled surface, which makes it practically impregnable to the action of the elements, thus preserving the reinforcement to a maximum degree.

The D. & A. Post Mold Co., manufacturer of the "Shaking System," is situated at Three Rivers, Mich.

EXHIBIT OF DILWORTH, PORTER & CO.

Dilworth, Porter & Co., Limited, of Pittsburg, Pa., in their space at the Coliseum exhibit of the Railway Appliances Association, showed an interesting line, consisting of a large variety of flat and flanged plates, and track spikes of all sizes from the $2\frac{1}{2}$x$\frac{5}{16}$-in. spike, for light mine track, to the $6\frac{1}{2}$x$\frac{5}{8}$-in. spike for service on heavy rail and under severe operating conditions.

The Goldie tie plate, manufactured by this company, is one of the oldest types of tie plate on the market today. An essential feature of a tie plate is that it must become an integral part of the tie, and it is claimed that this plate imbeds a minimum amount of metal in the tie, in meeting that requirement. They may be had 7, $7\frac{1}{2}$, $8\frac{1}{2}$ and 9 ins. in length, and of any width and thickness desired.

The Glendon flange and Dilworth shoulder flange plates are alike, except that the latter has a transverse shoulder on the top and is for use on curves where a shoulder is a prime requisite; the Glendon plate is more suited to tangent track. In designing these plates the idea was to secure adhesion to the tie at as small a damage to the wood fiber as possible. These are moderate priced plates for use on treated ties on tangents and light curves. Dilworth shoulder flange plates are made 7, $7\frac{1}{2}$, 8, $8\frac{1}{2}$ and 9 ins. in length, 5 and 6 ins. wide, and any thickness desired above $\frac{3}{8}$ in. The Glendon flange plates are made in widths of $4\frac{1}{4}$, 5 and 6 ins., $\frac{7}{16}$ to $\frac{3}{8}$ in. thick, and of any length desired.

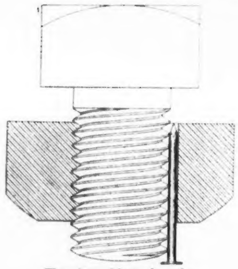
Among other types of plates made by Dilworth, Porter & Co. is the so-called Harriman type of plate, which is the standard plate of all the recognized Harriman lines. This type of plate, like all other plates, is designed primarily to prevent rail abrasion of the tie and not as a gauge holding plate. This flat plate combines strength and lightness, the longitudinal depressions in the top of the plate serving to decrease the weight with no loss of strength.

Among the types of spikes one design of the $\frac{9}{16}$ in. is made with the fillet or swell either on the back or front of the spike. All spikes smaller than 4x$\frac{1}{2}$ in. are made with the chisel point, and all sizes larger than this are furnished with either the chisel, round or Goldie (sharp) point.

Spikes with the Goldie or sharp point are especially serviceable in soft ties, as they destroy less fiber when being driven and offer much greater resistance to being drawn, the wood fiber obtaining a better and more lasting grip on the spike than on a chisel or round pointed spike.

TAYLOR LOCK NUT.

The lock nut illustrated is composed of a round pin fitting snugly in a novel shaped groove of uniform size cut entirely through the thread bore of the nut. The spaces on each side of the center of this groove diminish as the walls of the groove are approached.



Taylor Nut Lock.

The particular design of frog shown in the illustration is the result of years of observation, practical tests, and exclusive designing in combination with uniform distribution of dependable manganese steel.

The foot guarding provided in this design of frog is perfect, and meets the requirements of all railway commissions. The easer extensions at heel and toe protect the rails, and it is claimed that trains in riding over these frogs receive no impact either from the joints or the frog points.

R-N-R manganese frogs are manufactured by the Indianapolis Switch & Frog Co., of Springfield, Ohio.

When a nut is provided with such a groove and placed upon its bolt and a pin of suitable size to fit the center of the groove snugly is driven to place, the nut is locked to the bolt from a movement in either direction for the reason that the pin being round and in contact with the surface of the groove in the nut and in contact with the threads of the bolt, the slightest movement of either nut or bolt in either direction will cause the pin to wedge in the narrower parts of the groove. The side walls of the groove limit the movement of the pin if the nut or bolt should be forcibly turned, a condition which would rarely ever occur.

The pin is in full contact along the entire surface of the groove, also in contact with all of the meshed threads of the bolt; thus the maximum pressure is provided for and the maximum grip between nut and bolt upon the pin is secured for the entire depth of the groove.

Unless a nut is placed upon its bolt face down or where this device is used upon vibrating or moving parts of machinery, it is not necessary to drive the head of the nail beyond the screw end of the bolt. Where it is necessary to drive the pin far enough in so that the head rests in one of the thread grooves, it will be seen that the nut is not only locked to the bolt, but the pin is locked in the groove, making it impossible for the pin to jar out. With the nut, bolt and pin so arranged the effect is the same as if the nut was keyed to the bolt.

These nut locks are made by the Taylor Nut Lock Company, Boston Building, Salt Lake City, Utah.

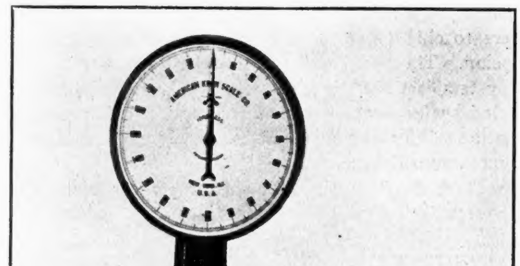
R-N-R SOLID MANGANESE CROSSING FROGS.

The Indianapolis Switch & Frog Co. has recently adapted its solid manganese type of frogs (formerly used only in switches) to frog crossings.

The R-N-R solid manganese frog has made good for crossovers and turnouts, and is now in extensive use on some of the largest railways. The frogs are equally efficient for frog crossings, netting a saving of joints in installation, eliminating maintenance and upkeep and requiring no renewals (during the life of the manganese) that necessitate removing the frog from the track.

THE KRON SCALE.

The Kron scale is an automatic dial scale, designed to meet the ever increasing demands from industrial concerns and transportation companies for an automatic, quick-weighing and accurate machine. Springs do not enter into its construction. The principle on which the Kron scale is based is simple and immediately appeals to any user of scales. This scale is instantaneous and accurate. The load is placed on the platform, and the



Automatic Kron Scale.

correct weight is read directly from the dial. Thus time and trouble are saved and the chances for mistakes are reduced to the minimum. The construction is of metal throughout. The frames are steel, the platform is of iron and steel and all metal is thoroughly protected from rust, and for these reasons the cost of maintenance is reduced to a minimum.

Kron scales are manufactured in designs as follows: express scale, dormant warehouse scale, railway freight and baggage scale, suspension track scale, recording scale, and portable warehouse scale.

The express type of platform scale is specially designed for express companies where a variety of different size packages, boxes and other articles are weighed in quick succession, the weights varying from 1 lb. up to 1,000 or 1,500 lbs. The weight in every case is ascertained instantly. The scale has no springs, weights or sliding poises, and the weight of each parcel is automatically shown upon the dial without vibration of the pointer which is "dead beat," so that it can be read instantly.

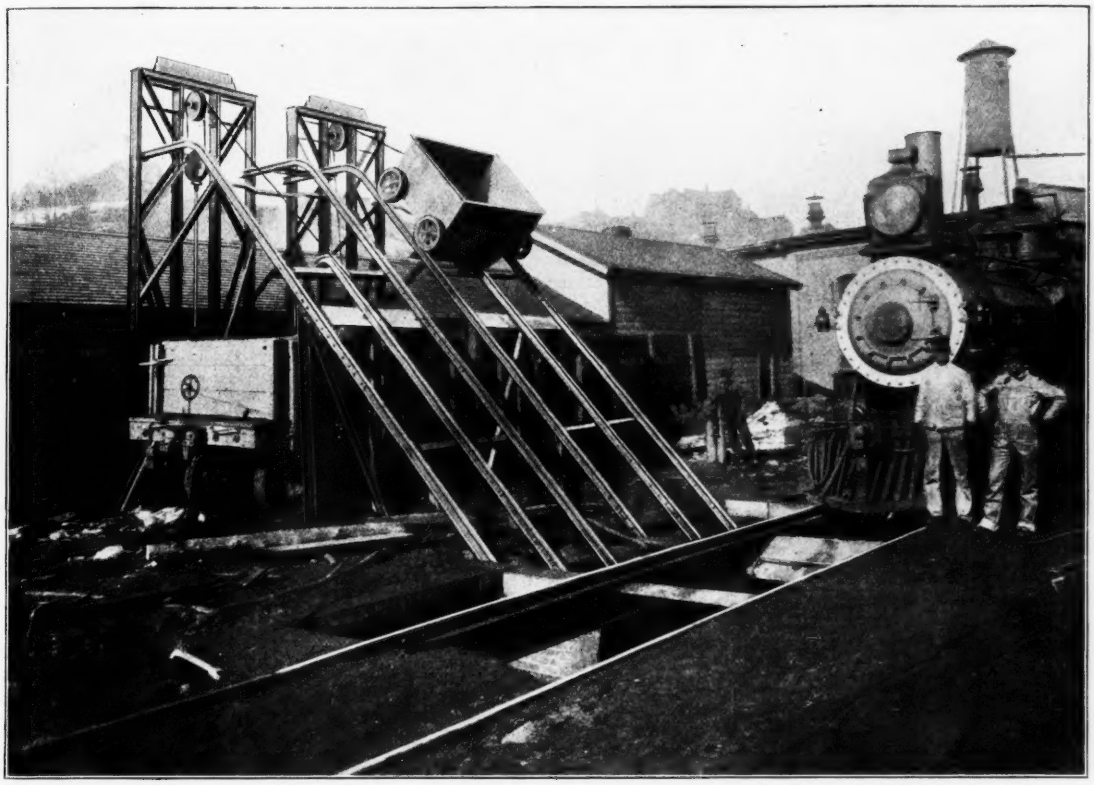
Where quick weighing is necessary the dormant warehouse scale will do the work of three or more scales of other types. The range is so large that it is adaptable to any business where it is desirable to weigh goods of any description accurately and swiftly in small or large quantities. It is designed to stand hard usage, only steel and iron being used in its construction, and it is built so as to give correct service for a long time without adjustment.

The railway freight and baggage scale is designed especially for use at railway stations for weighing freight and baggage, but is equally well adapted for use in warehouses, factories or stores. The dial can be placed at any reasonable distance from the platform; for instance, in an office or a booth. It is provided with a tare-beam which permits the net weight to be correctly read off by the weigher without calculation. If properly placed this scale can be used with advantage by two or more men working alternately, the weight of each draft being instantaneously shown upon the dial within the minimum time required for placing the draft upon the platform and removing it. The dial is graduated in 5-lb. divisions.

The recording scale registers the weight graphically upon a roll of paper by turning a handle. The records may be taken from the scale at any time by removing the paper whereon the weights are recorded. The recording mechanism is merely an attachment automatically operated upon by turning the handle. Scales of this type are supplied in capacities from five hundred pounds up to one thousand pounds.

In places like warehouses, etc., where the weighing cannot always be done in one place, there is manufactured a Kron portable scale with a large platform mounted on wheels so that it can be moved from one place to another. This scale is constructed entirely of iron and steel, is furnished with handles, and can be moved with ease.

The Chicago sales agent for the Kron scale is the Spencer Otis Company, 704-706 Railway Exchange.



Robertson Pneumatic Cinder Conveyor for Railway Cinder Pits.

ROBERTSON PNEUMATIC CINDER CONVEYOR.

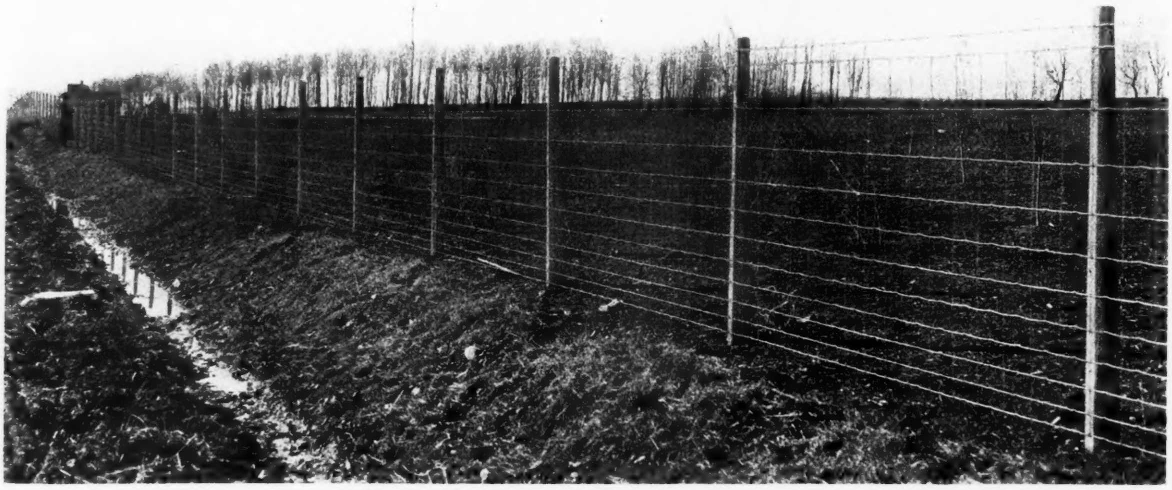
The recent Railway Appliance Show in the Coliseum, Chicago, included an exhibit of the Robertson pneumatic cinder conveyor demonstrated by the inventor and manufacturer, William Robertson & Co., 20 West Jackson Boulevard, Chicago.

The Robertson pneumatic cinder conveyor is not an experiment, but an assured success for railroad cinder pits, to which users testify. It can be adapted to any pit no matter what the requirements are. It has been tested on 37 railroads and given good service. Re-orders have been received from a majority of them, which is good endorsement. The cinders are dumped directly into the steel conveyor car, in the cinder pit under the locomotive. The conveyor car

is hauled up over the cinder car and deposits the cinders automatically. Cinders are removed from cinder pit to cinder car in about ten seconds. It is operated by compressed air from the roundhouse reservoir, or can at isolated terminals use air from the locomotive. The device eliminates long costly cinder pits, cinder pit repairs, depressed cinder car tracks, storage space in cinder pits, and delay.

PERMANENT FENCING BY THE "LUCK" SYSTEM.

Concrete posts have long since passed the experimental stage. Their wholesale adoption by the large railway corporations and by the United States government in its western reservation work is sufficient evidence of the satisfaction given by posts of this general type.



Luck Type Concrete Posts in Modern Fence.

Molds for casting concrete fence posts, which embody several original features, are being marketed by the Luck Cement Post Mold Co., 448 Mercantile Block, Aurora, Ill. The mold proper is made in two sections of heavy galvanized iron. Sections are held together by clamps that slide down a flange, and the mold as a whole separates longitudinally in the center. The standard sized mold is 7 ft. long, and turns out a post of that length, with an hexagonal cross-section, 5 ins. in diameter at the base, and 3 ins. at the top. The mold is pierced by 11 movable pins while it is still green, which are withdrawn after the concrete has set, leaving small holes through the body of the post, for attaching fencing of any type, line wire or mesh. The pins also serve the purpose of holding the reinforcement accurately in place while the concrete is being poured. The typical reinforcement has a cross-section of "M" shape.

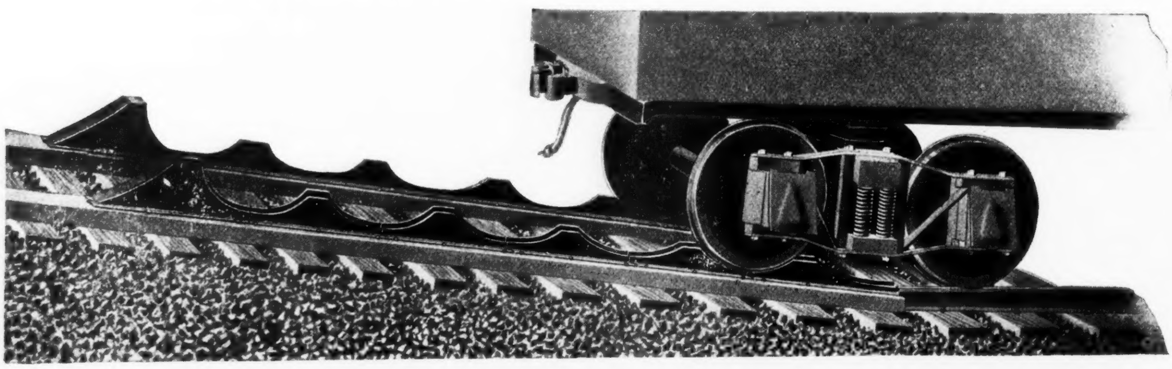
The wet process is used in making "Luck" posts, the mixture being poured in the molds and left in them for from 12 to 24 hours. The company recommends a 1:4 mix and figures that 20 cents per standard post, weighing about 90 lbs., is a conservative cost figure.

Interesting information, covering methods and costs of manufacture under this system, with suggestions for profit-making, will be forwarded to you by the company, upon request.

SAUNDERS CAR STOPPER.

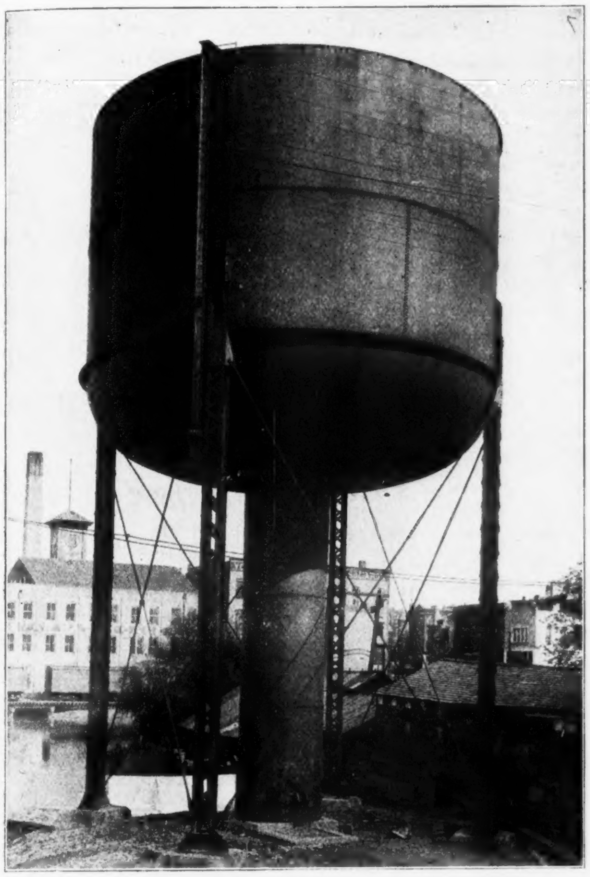
The car stopper illustrated herewith is a radical departure from the rigid bumping post. Some of the advantages claimed for this device are economy in price, low cost of installation, and low cost of maintenance.

It is also said that it enables the engineer to feel the end of the track. The moment the wheel hits the first corrugation, it is felt in the cab and the engineer can immediately apply his brakes. This device prevents the smashing which cars receive when they are standing close to a rigid post, and a coupling is made. With this stopper, no matter how hard the coupling, the car simply rises up and falls into the next corrugation.



Saunders Car Stopper.

It is claimed that its stopping powers are as great as those of any other post, but it accomplishes its purpose in a gradual manner and without damage to car equipment. This



Standard 1,000,000-Gallon Steel Tank with Elliptical Bottom.

device is manufactured by the Saunders Car Stopper Co., 113 N. 2nd St., St. Louis, Mo.

STEEL TANKS.

The Chicago Bridge & Iron Works manufactures a type of all steel tank with elliptical bottom for which it claims many points of superiority. Such a tank will not decay or burn, remains watertight, is durable, costs little to maintain and also presents a good appearance. The tank is designed with a large diameter and shallow depth, thus giving the minimum variation in pressure.

The riveted steel and drum (shown in the illustration) is made of sufficient diameter to prevent freezing, thereby eliminating the need of a temporary wooden frost casing. Thus the tank is strictly all steel both in summer and winter.

Some other points of advantage are: (1) The mud drum acts as a settling basin and is equipped at the bottom with a washout valve so the sediment can be washed out at any time without interrupting the service of the tank. (2) All surfaces are open for inspection and easily accessible for painting. (3) The cost of the tank erected complete is approximately the same as that of a wooden tank with a steel substructure. (4) It is built of any capacity up to 1,000,000 gallons or more.

In addition to steel tanks the Chicago Bridge & Iron Works manufactures stand pipes, oil tanks, creosoting plants, coaling stations, bridges, buildings, gas holders, and turntables.

EXHIBIT OF TRACK TOOLS.

One of the most elaborate and attractive exhibits at the Railway Appliances Association Exhibition was that of Hubbard & Co., Booths 197 and 198. The display consisted of track tools, shovels, spades, scoops and pole-hardware

Exhibit of Hubbard & Co. at Coliseum, Chicago.

This company was organized in 1843 and has since been actively engaged in the manufacture of iron and steel products. The present exhibit, of which we show an illustration, is, however, the first ever presented by the company at any railway exhibition.

The railroad track tools are made from solid steel, and stamped with the Hubbard trade-mark. All goods are sent out under the guarantee "free from defects in material and workmanship, and any tool found defective from either of these causes will be promptly replaced without charge."

In addition to standard track tools, this company manufactures a large number of patented tools, and makes a specialty of tools made to blue print or model.

The Pierce Specialty Department manufactures Pierce wrought steel brackets, hammer drills, expansion bolts, steel pins, etc. All steel used in these products is hot rolled, open hearth steel, galvanized by the hot dip process, giving a heavy homogeneous coating of pure zinc. The Pierce bracket is made with a resilient spiral thread which, while holding insulators securely, allows for expansion and contraction and the inequalities of their bores.

The headquarters of Hubbard & Co. are at Pittsburgh, Pa., and Mr. R. L. Mason is manager of the Railway Sales Dept.

Boltless P. & M. Anti-Rail Creeper in Position.

MODERN METHOD OF STOPPING TRACK FROM CREEPING.

Creeping track is a development partly due to the constantly increasing weight of locomotives and rolling stock, and the increasing speed and weight of trains out of proportion to the betterment in roadbed and track. The most common instance is on grades of .05 per cent and up, on track subjected to heavy traffic. In negotiating these grades heavy freights constantly apply and re-apply brakes. This application of the brakes causes a gripping and dragging action, in addition to the usual wave motion of the steel.

Curved track is another cause of creeping. Curves at the present time in almost all instances cannot be elevated to suit a uniform speed and are placed at a middle distance between high and low. The result is that high speed trains grip the high rail tightly in taking the curve and have a tendency to draw the rail along with them. On the contrary, if a freight takes the curve at low speed, the tendency is to lay on the low rail. Personal observation has developed that in almost all instances the high rail is affected a great deal more than the low, the latter being disturbed in only a few instances.

Soft or swampy underlying structure is probably the worst cause of creeping. The train in passing over such a spot catches the excessive wave motion in the rail caused by the soft substructure at the highest point of the wave. This will force level and tangent track to slide more rapidly than on severe grades.

Joints Driven Out of Position by Creeping Rails.

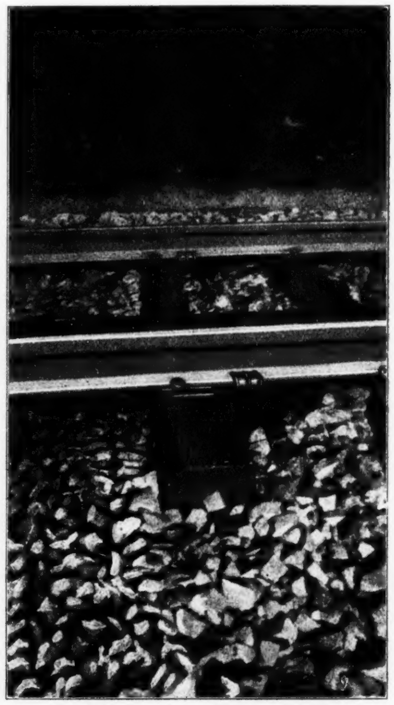
In bridges and trestles creeping is frequently excessive because the rail is very seldom slot spiked at the angle bars and the track is free to slide as it will. This it is evident is very troublesome in cases of draw bridges.

Whenever track creeps proper expansion spaces are lost, resulting later in kinks. With angle bars spiked in the slots and broken joints, the joint end of the joint ties is dragged off the tamped ballast, causing a low joint and even a broken joint, the ties are slewed around and thus the gauge is distorted, spikes are sheared, switches, frogs and crossings and interlocking connections are thrown completely out of line. With square joints both ends of the joint ties are pushed off of the tamped ballast, causing a low joint and necessitating re-spacing of ties.

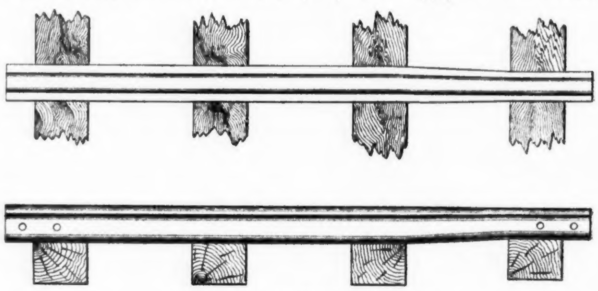
Many means of meeting this trouble have been tried with indifferent success, but within the last four years there has been developed a two-piece boltless anti-rail creeper, known as the "P. & M.," which is meeting the requirements. The quantity of these anti-rail creepers which should be applied varies with conditions; generally four to a rail is sufficient and in some cases only two to a rail are required; extreme conditions, however, demand extreme remedies, and applications as high as 12 and 16 to a rail have been made in which the use of this device has saved its cost sometimes in six months, frequently in one year, or one year and a half.

The best practice in applying anchors where broken joints are used, is to spike the angle bar in its slots and then apply the creeper on the opposite end of the ties, which must then be forced bodily through the ballast. The tie then moves with much more difficulty than as though it were free at one end and spiked to the joint at the other. Where four anchors are desired, the other two are placed at quarters of the rail. Where additional quantities are desired per rail, they are distributed evenly along the rail length.

The P. & M. Co. of Chicago, which markets this device, was formerly known as "The Railway Specialty & Supply Co." A corps of instructors and inspectors is maintained at this company's expense and these men are constantly on the road covering all parts of the country, and it is their duty to see that the customers of the P. & M. Co. get all possible benefit that they should get from the device. They instruct new men in its application; they see that the device fits properly and is manufactured of proper iron and is the proper design; they see that the railroad company applies the proper number of anti-rail creepers; not too many where the creeping is not severe, and not too few where the creeping is severe. The railroad may lose many of the benefits this device offers by trying to apply too few where



Two P. & M. Anti-Rail Creepers at the Quarters of the Rails.



Weir Frog Co.'s Taper Rails.

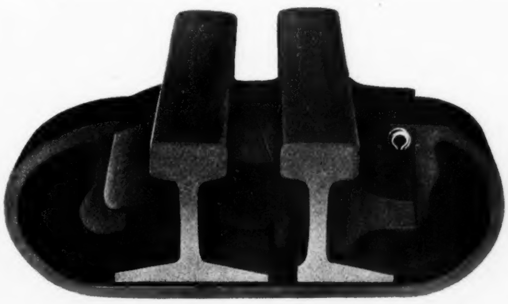
conditions are severe. To put all the creeping pressure against one tie will cause that tie to move more easily than as though the creeping pressure were distributed over several ties. Creeping pressure may even be severe enough to break the device where only one creeper is applied, whereas the application of two or four would do away with any breakage whatever, properly distribute the creeping pressure and save the railroad the cost of the device in a very short time.

The P. & M. Co. has just issued No. T2111 of their annual bulletin, describing the latest and most economical methods of applying the "P. & M." anti-rail creeper.

THE WEIR EXHIBIT.

One of the interesting exhibits at the American Railway Appliances Association, March 20, was that of the Weir Frog Company, Cincinnati, Ohio. This exhibit included taper rails, a solid manganese frog, and an adjustable guard rail clamp, as illustrated.

In the guard rail clamp the distribution of metal in the

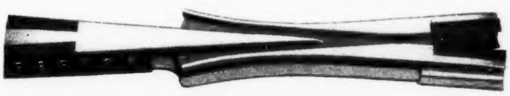


Weir Adjustable Guard Rail Clamp.

yoke is the distinguishing feature. Great durability and strength are claimed for this clamp, and it can be fitted with blocks for two sizes of rail. The taper rails are to be used in place of compromise rail joints. This appliance is not well known, but has been used successfully in a small part of the United States. Its economy and efficiency are bound to recommend its more general use.

The solid manganese frog shown was designed in the winter of 1906 and 1907; results aimed at were maximum strength and wearing surface with minimum weight.

The exhibit also included the intermediate switch stand, which is new on the market. It has a throw of 180°, thereby leaving the crank on a dead center at each end of the throw



Weir Solid Manganese Frog.

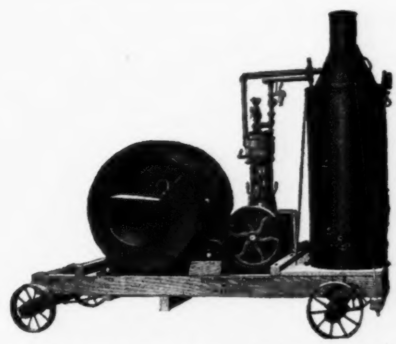
and placing the strains on the main bearings, instead of on the torsion strength of the shaft. The adjustable feature permits an easy adjustment of throw one-eighth of an inch at a time up to an inch, without in any way weakening the stand.

ECLIPSE CONCRETE MIXER.

The Eclipse concrete mixer, as illustrated herewith, is a machine especially adapted for various classes of work. Its special feature is the low charging drum which makes it necessary for the charging platform to be only about 24 inches high when the mixer is mounted on a truck high enough to discharge into wheelbarrows at the discharging side. This charging platform is mounted on the truck and the mixer is complete and ready for operation as soon as it arrives on the job.

The large opening in the charging end of the drum has another advantage in the fact that the entire batch can be seen while mixing and it can be determined, before discharging, that the concrete is in the condition desired. It is not necessary to discharge part of the batch to see whether it is too dry or too wet as often happens with mixers with small openings. The fact that the entire batch can be seen while mixing should enable the contractor to produce uniform high-grade concrete.

The discharging arrangement on this mixer is semi-automatic in that the discharge door is held in either mixing or discharging position by a strong spring under tension, and all that is necessary for the operator to do is to throw this door past the center of tension in either direction and the spring will complete the movement and hold the door until it is again thrown by the operator. This door can be thrown open for discharging and left open until the entire batch is discharged. The mixer is made to discharge about 3 cu. ft. (about one wheelbarrow of concrete) per revolution; the door can be closed after a barrow of concrete is discharged and left closed until the next wheelbarrow is in position. It is not necessary to have a special man operate the discharge door as the man wheeling can throw the lever without any difficulty. When discharging the concrete all in one batch the man who is feeding the mixer throws the door by the discharge lever which is at the charging end of the drum, so that an extra man is not required for discharging the batch. As the charging platform is only 24 ins. high, the material in wheelbarrows may be wheeled up a plank run-

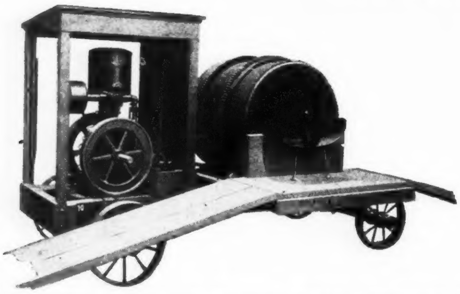


Eclipse Concrete Mixer with Steam Engine. (Discharging Side.)

way and dumped directly into the drum, which has a large opening. Thus the material is handled only once in getting it into the mixer.

When the work is being rushed and the concrete wheelers have become used to the work, the drum can be discharged without closing the discharge door after first opening it. In order to do this it is necessary to have enough barrows ready so that when the door is opened and the first barrow loaded from the first discharge revolution of the drum, the first wheeler will pull his barrow back from under the discharge chute and the second wheeler push in a barrow from the other side catching the discharge from a second revolution; then he will pull his barrow back and the third man come in from the same side as the first man and take the discharge from the third revolution. This method has been used frequently, and after a little practice the men take care of the mixed batch without any difficulty, the total discharge being made from a one bag batch in three or four revolutions.

It will be seen by this description that three revolutions are figured for mixing and four for discharging, and if the drum is operated at 14 r. p. m. there is still seven revolutions allowed for charging which should be done in three



Eclipse Concrete Mixer with Gasoline Engine (Charging Side.)

or four revolutions; so that by making one batch per minute there would be allowed about three revolutions for lost time.

The charging blades are set diagonally and made to overlap so that when the material is fed to the blades over the charging chute, it passes into the interior mixing portions of the drum as the blades advance and of course cannot return again as long as the drum is kept revolving. For discharging, there is a low blade extending across the drum leading to the discharge pockets. This blade carries over the balance of the material to the pockets when the drum is nearly empty, but is low enough so the greater part of the material falls over when the drum is full.

The Eclipse mixer will operate on either wet or dry mixing and with any kind of material. It can also be used for mixing cement mortar or top dressing for sidewalks, the smaller sizes being especially adapted for sidewalk work where a light portable machine is preferable; when it is desired to make top dressing, all that is necessary is to throw in a few pails of water to wash out the drum and then put in the sand and cement and mix same as regular concrete.

While the machine, as described, would be the ordinary outfit mounted on truck, the Eclipse is built in various styles and capacities, and is mounted to suit special conditions; it may be furnished with hoist for handling the mixed concrete when desired. The mixers are furnished with either gasoline, steam or electric power.

The Eclipse concrete mixer is manufactured by the Standard Scale & Supply Co., Chicago.

ASBESTOS LUMBER.

A number of materials for fireproof construction in building are manufactured by the Franklin Manufacturing Co., these include asbestos corrugated roofing, or sheathing, flat asbestos lumber, and asbestos shingles. The corrugated roofing is especially adapted for the construction of railway roundhouses, in connection with asbestos lumber smoke jacks. The entire roof structure is thus composed of fireproof material.

The New York Central & Hudson River R. R. has made a novel use of these asbestos lumber products, in the reconstruction of the East Buffalo sheep sheds, which were destroyed by fire. Each stall is lined and roofed, and the outside also is covered with the asbestos products. If a fire should start in any stall, it will be impossible for it to communicate to an adjacent stall.

For roundhouses this construction is lighter and the heavy timbering necessary for cast-iron jacks is not required for the asbestos lumber smoke jack; the latter are impervious to the action of the sulphurous gases and acids, and will last for an indefinite period. The New York Central R. R. has recently put in service an engine house of this design at New Durham, N. J.

The Franklin Mfg. Co., of Franklin, Pa., is the exclusive distributing agent for the United States for all steam railroad work.

Industrial Notes

The Allen & Garcia Co., McCormick Building, Chicago, has been incorporated by Andrews Allen and John A. Garcia. The company will specialize in steel, concrete and timber structures, including coal tipples, bank-heads, coal storage, screening and power plants, bridges and foundations and drawbridges.

Victor W. Ellet, general foreman of the Chicago, Rock Island & Pacific, at Rock Island, Ill., has resigned to go to the Hunt-Spiller Manufacturing Corporation, Boston, Mass.

The Pennsylvania Railroad is asking for prices on steel wheels for use on the cars which it is now building at its Altoona shops.

The Railway Steel-Spring Co. is operating its plants at approximately 75 per cent of capacity. It reports that a

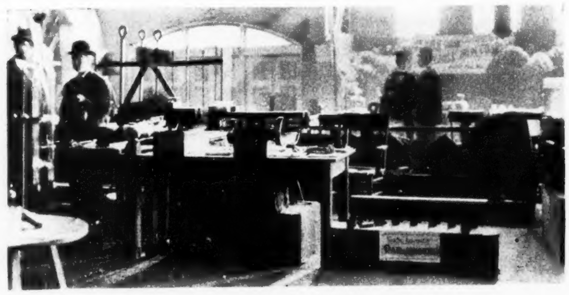


Exhibit of the American Guard Rail Fastener.

number of orders are coming in for repair and replacement work.

Seely Dunn of New Orleans, La., has been appointed sales agent of the Bullard Car Door Equipment Company, Birmingham, Ala., and will represent that company throughout the country in introducing its fixtures for freight car doors Mr. Dunn was for several years a division superintendent on the Louisville & Nashville; later connected with several railways in the West, and subsequently became manager of the Southern Car Service Association at New Orleans.

E. J. Caldwell, for 12 years with the Illinois Central, and for six years private secretary to the president, has accepted a position with the Barrett Manufacturing Company, Chicago, as railway representative, with office at Chicago. This

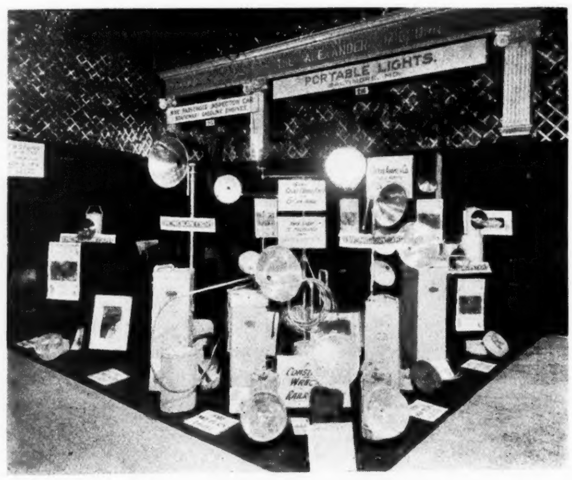


Exhibit of the Alexander Milburn Co., M. of W. Convention.

position was created by the company especially for Mr Caldwell.

Plans for the reorganization of the Southern Car Company, High Point, N. C., have been completed. J. B. Duke, president of the American Tobacco Company, Jersey City, N. J., and W. G. Brokaw, of New York, have taken the lead in the reorganization.

At the annual meeting of the Bethlehem Steel Corporation, Newark, N. J., the following directors were added to the board; Harry Bronner, of Hallgarten & Company, New York; B. H. Jones and E. C. Grace. The last two directors are associated with the Bethlehem Steel Corporation in an official capacity.

The Call Switch & Frog Co., Denver, Colo., has been organized for the purpose of establishing a plant on West Eighth avenue. Mr. R. A. Call is president of the company.

The United States Metal Products Company, 203-205 West Fortieth street, New York, has plans under way for an addition to its Rapp plant at College Point, L. I., which will involve the erection of a shop, 250 ft. x 600 ft., a dock, 75 ft. x 600 ft., and an employees' bath house, 50 ft. x 60 ft. The officers of the company are as follows: President, John W. Rapp; vice-presidents, H. C. Randall, C. J. Hale and A. J. Connell; treasurer, E. B. Wires, and secretary, C. A. Leonardi.

Thomas A. Edison, Incorporated, has taken over and will carry on the business heretofore conducted by the Edison Manufacturing Company. All contracts and agreements to which the Edison Manufacturing Company is a party have been assumed by Thomas A. Edison, Incorporated.

The Westinghouse Electric & Manufacturing Company, of Pittsburgh, Pa., has just received an order from the Georgia Railway & Electric Company, Atlanta, Ga., for six additional double equipments of No. 112B-2 motors with type K-35 control. The Toledo, Bowling Green & Southern Railway of Findlay, Ohio, has recently placed an order with this company for four quadruple equipments of No. 304 interpole railway motors with latest type HL (hand operated) unit switch control. An order for five double equipments of No. 93-A motors with type K-11-A control has also been placed with this company by the Johnstown Passenger Railway Company, Johnstown, Pa. This company has recently received an order from the Fairmount & Clarksburg Railway Company, Fairmont, W. Va., calling for four additional quadruple equipments of No. 306 interpole motors with HL (hand-operated) unit switch control. The City Railway Company, of Dayton, Ohio, has just placed an order with the Westinghouse Company for ten double equipments of No. 306 interpole motors with type K-36 control. An order for four double equipments of No. 307 interpole motors and type K-35 control has recently been received by this company from the Nashville Railway & Light Company, Nashville, Tenn. The Cincinnati Traction Company has recently placed with the Westinghouse company an order which calls for nine quadruple equipments of No. 303-A interpole railway motors and HL (hand-operated) unit switch control. This company has just received a contract from the British Columbia Electric R. R., of British Columbia, for two 45-ton locomotives with quadruple equipments of No. 301 interpole railway motors and automatic unit switch control.

The Pawling & Harnischfeger Company, Milwaukee, Wis., has elected the following directors: S. H. Squier, W. H. Hassenplug and F. P. Breck. Mr. Squier has been elected also secretary, and Mr. Hassenplug, formerly sales manager, has been elected also second vice-president.

Mr. James A. Campbell has been elected a director of the Lackawanna Steel Co., for the term expiring 1913. The other directors have all been re-elected.

Mr. John B. Milliken, treasurer of the Yale & Towne Manufacturing Co., has been elected a director of the company to succeed Mr. A. R. Erskine, resigned.

The Universal Nut & Bolt Lock Co., Cincinnati, Ohio, has been incorporated to manufacture nut and bolt locks. The incorporators are F. B. Alter, E. E. Walters, Chas. A. Farrell, N. E. Kruney and J. L. Jones; capital, $60,000.

Mr. L. C. Thompson, of Omaha, Neb., has recently been appointed representative of the Concrete Form & Engine Co. for Omaha and vicinity. Mr. Thompson has long been connected with the gasoline engine industry and is unusually well fitted to represent this company in his section.

The St. Louis Car Co., St. Louis, Mo., has appointed the Wendell & McDuffie Co., New York City, as its sole eastern agents.

The old quarters having proven unequal to the growing demands of its business, the Central Electric Co., of Chicago, has just completed changes which will nearly double its facilities. The offices are now on the top floor of the six-story building, where the arrangement of skylights will make artificial light unnecessary most of the time. The increase in floor space available for stock purposes, amounting to about 25,000 square feet, may be of interest to the trade, as it will enable the company to increase both the quantity and variety of its stock, work out in finer detail the system of stock-keeping and shipping, and to maintain and improve its well-known reputation for prompt and aggressive work in the interests of its customers.

Following the consolidation of the New Belle Isle Motor Co. and the Collapsible Steel Form Co. into the Concrete Form & Engine Company, of Detroit, comes the announcement that L. K. Rumsey has been elected secretary-treasurer and Wm. P. Shonefeldt elected general manager of the new company. W. D. Waugh, who originated and worked out the details of the plans which involve the fitting of a Belle Isle engine into the frame of a velocipede for railway purposes, has been appointed assistant general manager. The plans are now under way for the erection of a larger plant to take care of the growing business of this new concern. The Belle Isle engine, which was originally used only for marine purposes, has now become very popular in the railway world for use on the railroad velocipede. A stationary engine for farm purposes designed from the original plans of the Belle Isle motor will also be produced at this factory in great quantities.

The Tinsley Railway Supplies & Equipment Co., McCormick Building, Chicago, has closed a deal with the Van Dorn & Dutton Co., of Cleveland, Ohio, to handle its entire line of cut and planed gears, gears and pinions for electric railway motors, hard service electrically operated portable tools, armature, field, and induction motor coils.

The United States Steel Corporation was the lowest bidder for the construction of six emergency dams to be erected on the Panama Canal.

John Langan, of the Okonite Company, New York, has resigned. His retirement from active business to take a much needed rest is due to a recent illness. Mr. Langan is an associate member of the Railway Signal Association, and the standard specification of that association for 30 per cent compound rubber covered wire was the outcome of a movement started by him.

The American Car & Foundry Co. has taken out a building permit at Wilmington, Del., for a steel and concrete structure, to replace a frame building. The estimated cost is $10,200.

The Canadian Westinghouse Company in 1910 earned for dividends $567,393, against $428,379 in 1909, the percentage on the stock being 12.97 per cent, against 10.14 per cent, even though the stock was increased during the year to $4,376,600.

As a forerunner of the annual Master Car Builders' convention at Atlantic City in June, we have received information from the Royersford Foundry & Machine Co., of Royersford and Philadelphia, Pa., that it has engaged double space this year, in which an even more comprehensive exhibit than ever will be made of "Sells Roller Bearings," "Rollerine," the new roller and ball bearing lubricant, and "Punching and Shearing Machines," all products of the Royersford Co. Manager John D. Sells will be in charge as usual.

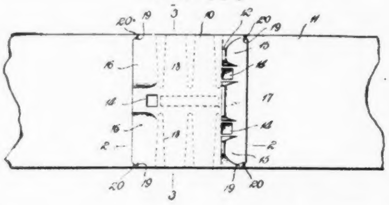
Recent Engineering and Maintenance of Way Patents

CEMENT AND STEEL RAILWAY TIE.
986,920—William J. Horn, Lamar, Mo. Filed Mar. 3, 1910. Serial No. 547,055.

A reinforced cement railway tie, the reinforcement consisting of a base and a top bar, with connecting uprights. Lugs project upward from the top bar to engage the rail seats. Rails to be fastened by rail securing wedges.

986,819.

986 698



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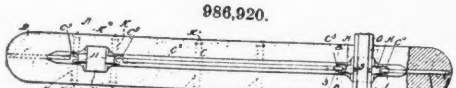
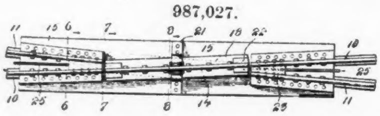


987,027.



SWITCH FROG.
987,027—James W. Wallis, Trinidad, Colo. Filed Jan. 31, 1910. Serial No. 541,118.

This switch frog consists of a solid steel plate on which a short piece of rail is pivoted. This pivoted rail may be swung around to form continuous track in either of two directions, filling up the space between the immovable frog rails on either end of the plate.

RAILWAY TIE PLATE.
986,698—John W. Doster, Kingsland, Ark. Filed April 5, 1910. Serial No. 553,503.

This tie plate is designed with a concaved lower face to facilitate the shedding of water. From this lower face a number of ribs for engaging the tie extend. There is a shoulder rib on the top surface, against which the outside of the base of rail is to rest.

ANTI-CREEPER FOR RAILWAY RAILS.
986,860—Joseph J. Quinlan, Alliance, Ohio. Filed Jan. 14, 1911. Serial No. 602,637.

This anti-rail creeper is composed of a main body adapted to be arranged transversely under the rail, provided at one end with a tie engaging lug, and on the other with a rail-base engaging flange. The base engaging flange is forced against the rail by means of a wedge shaped pin, which is driven into an engaging hole in the body of the main body yoke.

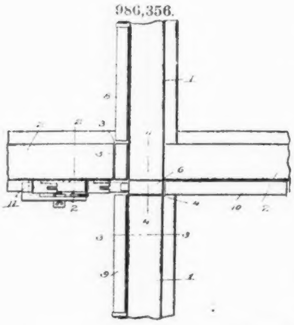
PILE TUBE.
986,819—John McGranighan, Roxboro, Pa. Filed Nov. 3, 1910. Serial No. 590,496.

This pile tube is provided with a removable point, composed of truncated cone sections. A rod extends from the point to the top of the tube, for holding the point in place, and for pulling the point up after the pile tube is driven.

ADJUSTABLE CAR PARTITION.
986,810—John Dixey, Chicago, Ill. Filed Feb. 26, 1910. Serial No. 546,228.

This invention is composed of a car partition supported from longtudinal horizontal rails. The partition is adapted to be swung into and out of a vertical position. The flanges of the supporting rails are provided with a series of shoulders, and means are provided for locking the portion in a vertical position at any of these shoulders.

986,356.



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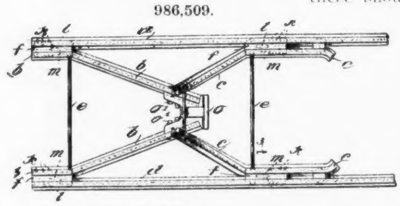
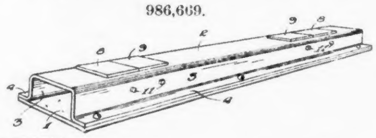


986,669.



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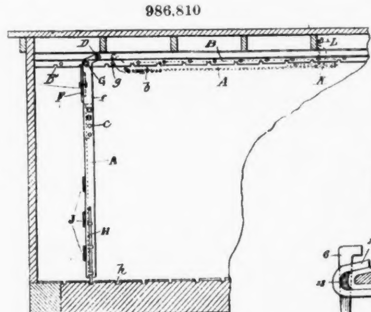

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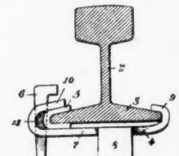


BUMPING POST.
986,509—August E. Schultz, Chicago, Ill. Filed Nov. 22, 1910. Serial No. 593,725.

A railway bumping post including flanged base rails, a bumping block, flanged rails supporting the bumping block and filler blocks interposed between the base rails and the bumping block supporting rails, and received into notches provided in the flanges of said rails.

RAILWAY CROSSING.
986,356—John H. Brumback, Strasburg, Pa. Filed Nov. 18, 1910. Serial No. 593,106.

A rail crossing containing blocks to fill in the flange spaces, and make the track continuous. The filler blocks are moved by a flange-operated lever. When this lever is pressed down, the block is removed, leaving the flange opening unobstructed.

RAILWAY SPIKE.
985,519—Charles A. Flanagan, Colorado Springs, Colo. Filed Feb. 18, 1910. Serial No. 544,699.

A spike, the body of which tapers to a point, a section of the taper being greater than the remainder, so that a shoulder is formed for gripping the wood of the tie, when a vertical strain is put on the spike.

RAILWAY TIE.
986,669—Edwin R. Axelson and Charles B. Desmond, Richmond, Cal. Filed May 11, 1910. Serial No. 560,628.

The tie comprises a flat base plate upon which is bolted a beveled body with upturned sides, fastened to the base plate through flanges. Outturned near the ends of the upper structures are pockets to contain blocks, on which the rail is to rest. The blocks are fastened by horizontal bolts, through the sides of the metal body.

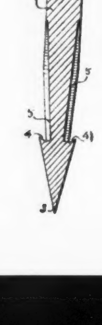
COMBINED RAIL JOINT AND SPIKE PROTECTOR.
985,867—William A. Walker, Racine, Wis. Filed May 31, 1907. Serial No. 376,721.

An angle bar having the transverse sides of the spike holes formed by integral ears struck from the metal of the angle bar, and presenting rounded surfaces to the throat of the spike.

RAILROAD TIE AND RAIL FASTENER.
986,214—John J. Planett, Amarillo, Tex. Filed Mar. 8, 1910. Serial No. 547,971.

A concrete railroad tie gradually increasing in width from the center to the ends to operate in connection with adjacent ties to retain the ballast between them, with the sides of the tie presenting smooth uninterrupted faces from one end of the tie to the other.

985,5



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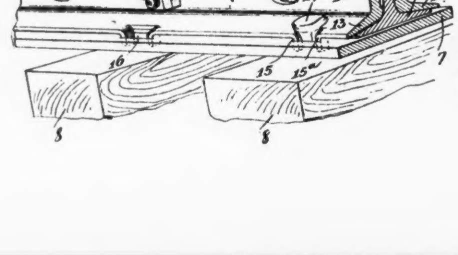

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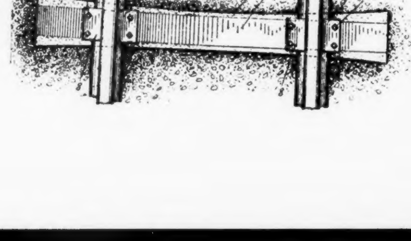

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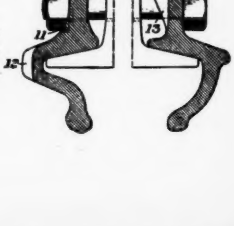

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